MESSAGE TO MEMBERS FROM THE PRESIDENT, Mr. G. E. BAILEY

SIX months ago, when the gravity of the war situation clearly called for a departure from established routine, I issued an appeal for special co-operation among our members, asking you to help one another in dealing with shortages and " bottle necks " particularly with regard to machine capacity, technical assistance, labour, and stores. I emphasised that our Institution would render a great national service if it could effect co-operation along these lines. The response to that appeal came without delay. Steps were also taken by the Institution to set up a War Emergency Committee. In effect, this has meant that the Council of the Institution has since been meeting every week or so to consider many of the major technical problems affecting the country's war production, not only from the point of view of our members themselves but from the national point of view as well.

Much of the work of that committee is known to you through its published documents and the reports that have appeared in the regular and special editions of the Institution's *Journal* and *Bulletin*. Other sections of its work, necessarily less known, are carried out through contacts with official circles. Between those circles and our Institution there is a growing measure of understanding and goodwill. It was not easy for them to appreciate that a young scientific body such as ours might have an effective contribution to make to the right handling of the national war production.

Among the questions that are now occupying the attention of our War Emergency Committee are those of tooling, and the efficient utilisation of labour for war purposes. You will have read in *The Journal* the committee's memorandum on the latter subject, which is one in which I take a special interest, not only as your President but as President of the Engineering and Allied Employers' National Federation.

May I be excused, therefore, if I stress the great importance of this question of labour from the national point of view. Man power and its efficient utilisation is probably the most important problem the nation has to face, whether it be in the services or in the many phases of war production.

Many of our members are directly and vitally interested in the important problem of labour supply for the engineering industry. Vastly increasing numbers of workpeople will be required in the

immediate future as new factories are equipped and become available and existing plants expand. Special appeals will be made to supplement the training of the Government training centres.

The first demand is for skilled toolmakers and skilled machinists (particularly setters-up) and fitters. The toolmakers must be provided by stepping up the higher skilled artisans engaged on production. These must be replaced and the additional skilled machinists and fitters provided for production by stepping up semi-skilled males and by using female operators.

All this work will involve more effort, more anxiety, and more responsibility for the already overworked production staff. Furthermore, it is not sufficient for us to train only for our own requirements. We must train for the Ministry of Labour's requirements also, to facilitate the starting up of the new factories I have already referred to.

Details of the Government scheme for training are available, and I make the strongest possible appeal to members to assist to their maximum capacity with this grave national problem. If they have not already done so they should apply to their Local Labour Supply Committee and find out their requirements. I know you will have disappointments, but do please persevere and assist to your maximum capacity.

In addition to the work of the War Emergency Committee, it must be a source of satisfaction to us all to note that the work of our new Research Department has been continued without interruption, in spite of serious financial limitations and difficulties in providing much needed equipment. The results of our research into the problem of surface finish will shortly be made available, investigations on cutting tools are in progress, a report on belting has been completed, there is a steady demand for the publication of Acceptance Test Charts for Machine Tools, the next instalment of which will soon be issued, and a valuable report appeared last month on how to measure and maintain accuracy in machine tools. Much of this research can be of direct and immediate advantage in the production of a wide range of war stores.

All this affords ample evidence that our Institution, far from confining itself to the normal peace-time activities of a scientific society, is doing its utmost to see that in their collective capacity the special knowledge and experience of production engineers is utilised in the service of the nation at this juncture. Much depends on the skill, the fibre, and particularly the leadership shown by our members in the present emergency. This is a testing time for everyone, and for none more than the production engineer. He must not fail his country. I am sure he will not.

In the time ahead, however, our aim must be not only to maintain production, whatever befalls, but to increase it. That is the task

before each of us in our own workshops, but I want members as well never to lose sight of the fact that we have in our Institution, if we use it properly, a medium to ensure that the best thought of production engineers for strengthening the nation's war effort in the factories can be pressed effectively upon the attention of the Government. If members have production problems on which they want advice or on which they can offer advice, they should make the utmost possible use of the Institution.

I have referred above to our War Emergency Committee and I wish to record my appreciation of their splendid devotion to the Institution and the excellent work they have achieved.

These notes would be incomplete without reference to our indefatigable Secretary, Mr. Hazleton, and his staff, who have " carried on " in spite of inconvenience and discomfort caused by enemy action. We are very fortunate in having for our Secretary a man of such wide knowledge and ability.

Christmas and the New Year are close at hand. Even if the festivities usual at such a time are not possible because of the war, it is open to us to exchange heartfelt greetings and good wishes. These I send to all of you, proud of the work you have already done and confident of your future achievements.

G. E. Bailey, *President.*

December 16, 1940.

EFFICIENT CONTROL AND DISPOSAL OF SWARF AND SCRAP METAL

**Paper by D. F. Galloway, Whit.Sc., B.Sc.*

This paper describes methods and equipment for the economic control, disposal and recovery of scrap metal in the form of swarf. Chip control, de-swarfing of machines, recovery of cutting oil, swarf breaking, sorting, sintering, baling, and magnetic handling are among the processes mentioned. Special attention is given to the efficient recovery of aluminium which is so vital to the present war effort.

Factors and Processes Involved.

EVER-INCREASING production, and the growing demand for a strict economy in material during the war emergency has focussed the attention of most production engineers on the problem of economic swarf disposal and the efficient recovery of scrap metal. Some firms already have highly efficient systems for handling swarf and scrap, but many firms must now begin to give this problem greater attention as the urgency for conservation of material grows. The problem of handling swarf has no universal solution which is suitable under all circumstances. Many of the factors which govern the most economic production of a job also apply to the problem of economic swarf disposal, for the most suitable procedure will depend on the material of which the scrap is composed, brass, bronze, steel, cast-iron, etc., the total quantities of scrap involved, the rate of production of scrap, the form of the scrap, small chips, long streamers, scrap workpieces, metal plate or strip, etc. Another relevant factor is purity of scrap, i.e., whether it consists entirely of one material or is a mixture of several metals. Yet another factor is the method of scrap disposal for recovery of the material, i.e., whether the metal is to be sold to a dealer for remelting or whether the firm is to remelt it for their own foundry. Only when all the foregoing factors have been thoroughly investi-

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NOTE.—This paper is published as a basis for the exchange of members views and experiences in the problems of swarf disposal. The editor would be glad to receive information regarding difficulties which have been encountered and overcome so that the Institution can place at the disposal of its members a survey of current practice. Information should be addressed to: Technical Editor, Institution of Production Engineers, 36, Portman Square, London, W.1.

gated and carefully considered is it possible to prescribe the most efficient method of scrap disposal for any particular case.

Before the economics of scrap disposal can be considered it is necessary to have a clear conception of the processes involved and the various means available for performing each stage of the disposal. The sequence is approximately as follows—

(1) Initial control of scrap metal as it is removed from the bar or strip, leaving the required workpiece.
(2) Immediate storage of swarf in or near machine base.
(3) Removal of scrap to main storage or sorting department.
(4) Separation of coolant from swarf and breaking if necessary.
(5) Sorting of different materials if necessary.
(6) Baling, storage, and removal to melting plant.

Initial Control of Swarf.

The metal chips produced by such processes as milling, sawing, grinding, etc., are usually fine enough to be controlled without special devices, but the swarf resulting from turning, boring,

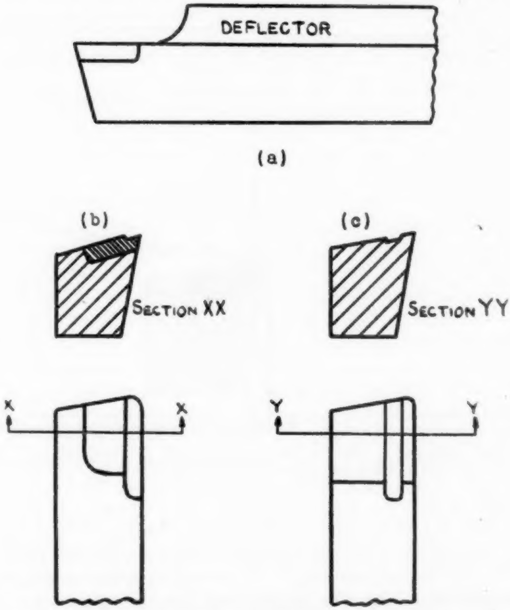
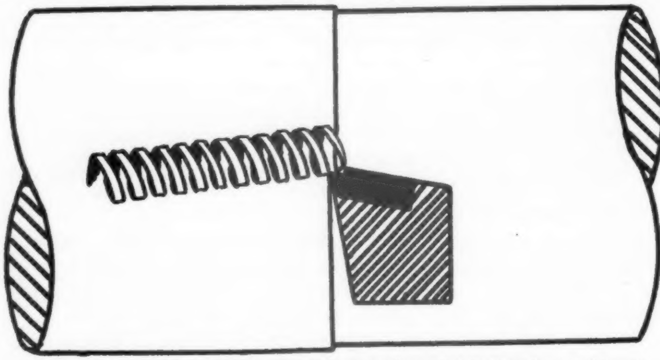


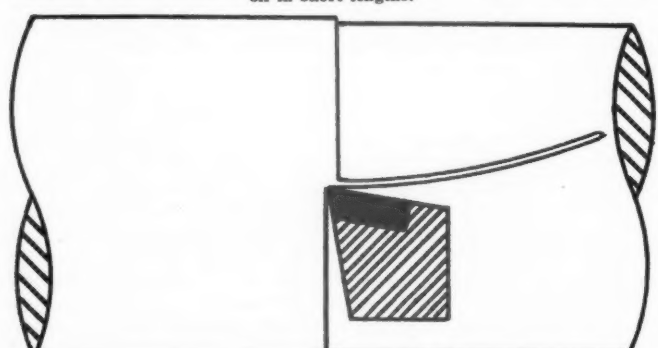
Fig. 1.—(a) Adjustable deflector. (b) Effective chip breaker. (c) Tool edge weakened by undesirable chip breaker.

drilling and similar operations is often produced so rapidly and in such a form that it is necessary to take special precautions to control the scrap metal immediately it leaves the work-piece.

Swarf from machines using single-point cutting tools can be broken and controlled by means of chip breakers and deflectors as



(a) CHIP BREAKER. Curled swarf coils away from finished surface and breaks off in short lengths.



(b) NO CHIP BREAKER. Flowing chips which become a tangled mass difficult to handle and injurious to finished surface.

Fig. 2.

shown in Fig. 1. It is important, when grinding chip breakers on such tools, to ensure that the correct cutting angles are maintained, so that the inevitable reduction of cutting efficiency is kept to an absolute minimum. Besides controlling the dangerous and rapidly accumulating chips produced by heavy roughing cuts, chip breakers

and deflectors are useful during light finishing cuts for keeping chips away from the machined surface where they are liable to spoil the finish.

If the chip breakers used on single-point cutting tools are correctly ground the swarf will curl away from the surface of the work-piece and break off in short coils, Fig. 2 (*a*), which are convenient to handle in the process of swarf disposal. If no chip breakers are used on tools cutting ductile materials such as steel, the chips tend to flow in the form of long strips, Fig. 2 (*b*), which are apt to score the surface of the work-piece or become entangled in moving machine parts and " jam " between the work piece and the cutting tool. This may result in scrapping workpieces and breaking tools, especially cemented carbides which are too brittle to withstand such shock. The necessity for adequate chip control is accentuated by the growing use of carbide tools capable of cutting tough steels at such high speeds that an overwhelming mass of unmanageable swarf is frequently produced. However, apart from the slight reduction in machining efficiency, carbide tools are very effective with ground-in chip breakers because they retain their form much longer than similar breakers ground in high speed steel tools. The most efficient breaker for any given job can be determined by experience, but if a breaker of the form shown in Fig. 1 (*b*) is used when cutting steel, it should have a depth of about .010 in. to .020 in. and a width approximately equal to three times the feed. Some users prefer breakers of varying width, so that the step is not parallel to the cutting edge. It is claimed that this definitely breaks the coils into convenient short lengths. However, in general the parallel breaker is quite effective. Chip breakers are not necessary for intermittent cutting such as occurs when taking first roughing cuts on irregular work-pieces or when machining across slotted or broken surfaces.

Chip breakers can be ground by hand but it is preferable to grind them in an appropriate fixture on a cutter grinder or a surface grinder. To obtain the best results it is desirable to use an impregnated diamond wheel.

The long spirals produced during heavy drilling operations using large diameter drills on steel, can generally be broken by " staggering " the drill. By simply grinding grooves on the drill lips as shown in Fig. 3 the chips are made more manageable and the first stage of swarf control is facilitated. Alternatively, a shallow groove just above the inside face of the lip and parallel to the lip edge makes an effective chip breaker. A disadvantage of this latter device is the loss which inevitably occurs when the groove is reached during subsequent grinding.

Numerous investigations have been made to determine the correct size and form of the helical flute along which the chips must pass to

clear the drill point. The problem is very complicated, for any increase in flute cross section is accompanied by a reduction of cross section of the drill itself, which causes a reduction of torsional rigidity. In addition, the helix angle of the flute affects the main cutting angle of the drill tip so that the demands of efficient chip disposal must often give way to other factors involved in the machining operation. How widely these factors fluctuate can be gathered by a perusal of the values for flute angles, etc., prescribed for drilling various metals. However, experiment and practice alike show that by the use of correctly ground drills, having the appropriate flute helix angles, many of the problems of swarf disposal can be eliminated.

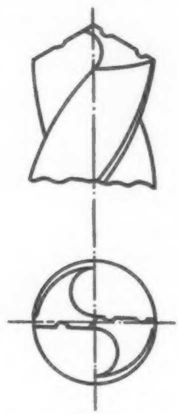


Fig. 3.

Moreover, care in these matters results in greatly improved output, more holes per grind, and less power consumption, thus effecting an all-round increase in efficiency.

Separation of Swarf from Workpieces.

When the swarf produced during machining leaves the cutting tool it passes to the pan or base of the machine if the tool is properly ground. In the case of automatic bar turning machines the finished job, when parted off, is liable to fall among the swarf, but separation of component and swarf is effected by means of a deflector or other automatic device, Fig. 4. The cam *C* is set so that the deflector swings into the swarf and work chute just as the job is severed, causing it to fall into a tray or strainer at the front of the machine. At this time the deflector is in the position *A* shown by full lines. The deflector then returns to its normal position *B* shown dotted,

and the swarf falls straight through the chute to the strainer below. On some automatics where an extra operation such as screw slotting, etc., is performed after parting off, the job is automatically carried on an arm from the turning spindle to the attachment which performs the extra operation. Thus the swarf alone passes to the pan of the machine and the work-piece is finally ejected at the front of the machine.

In the case of very small workpieces the process of separating them even from small quantities of swarf is very difficult. For this

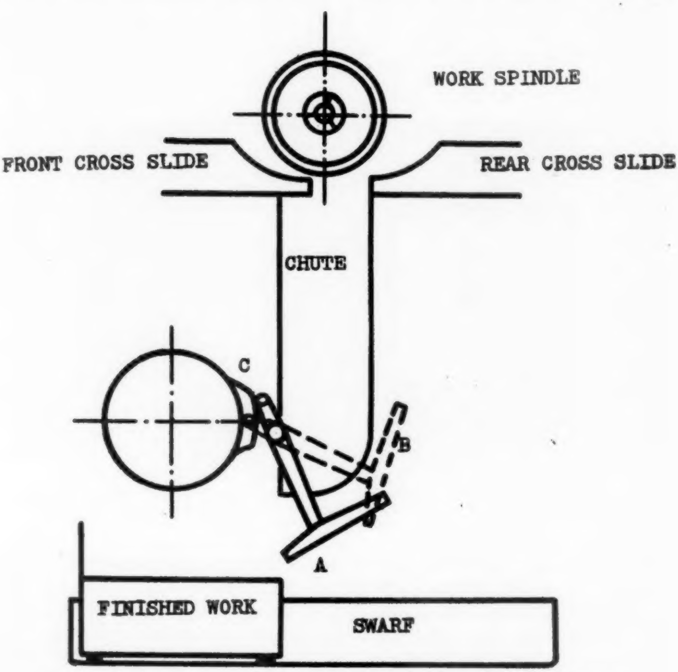


Fig. 4.—Cam operated deflector for separating workpieces from swarf.

reason a transfer arm similar to that incorporated in screw slotting and other attachments is used to ensure that workpieces are delivered in a clean condition.

The problem of getting swarf from the cutting-point to the pan or base of the machine is one to which not only the tool designer but also the machine designer must give a greater measure of

attention. By the introduction of sloping surfaces where possible, by the elimination of all unnecessary recesses or projections, and in some cases by tilting the whole machine, it is possible to facilitate swarf disposal without impairing the functions of the machine. The result is a considerable gain in efficiency.

Removal of Swarf from Machines.

The next stage is the removal of the swarf from the machine. In many workshops where the rate of swarf production is not great the method of handling is to arrange under or near the machine a pan or bin into which the chips can fall or be easily tipped. The smaller bins are readily removed by hand, but larger bins or pans should be set on feet so that an elevating truck, capable of passing under

Fig. 5.

the machine as shown in Fig. 5 can be used for rapid removal. This method is quite effective for small to medium machines, for one man with an elevating truck can attend to a large number of bins. At the machine the man has merely to run the truck under the bin, depress the pedal to raise the bin clear of the floor, and withdraw truck and bin. The bin can be emptied by hand or if too heavy for convenient handling, special elevating trucks are available which will lift and tip bins as required.

In the case of machines which have raised pans the swarf can be scraped from the pans into barrows. Shovels and brushes are adequate for dealing with small chips, but where the swarf is in the form of long streamers or spirals a rod hooked at one end and having a handle at the other facilitates quick and safe handling. On some

large machines such as large lathes, single and multi-spindle automatics, etc., where the rate of metal removal is great, various forms of automatic conveyors are incorporated.

The conveyor shown in Fig. 6 is fitted to a single spindle automatic screw machine and is operated by the end cam shaft. The chips are automatically conveyed by a spiral mechanism *AB*, to the end of

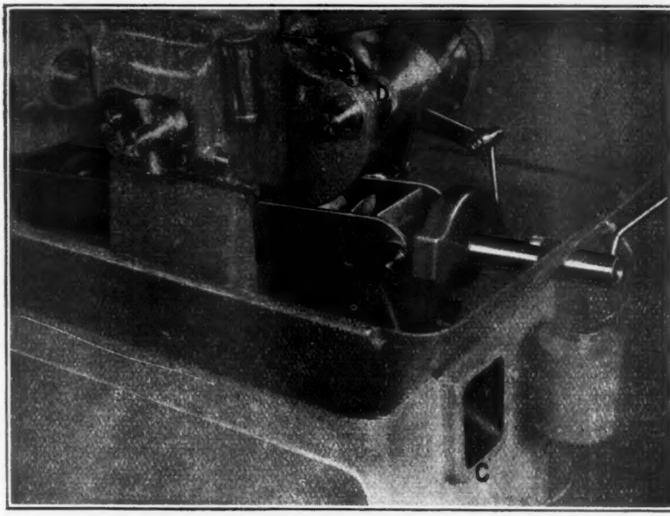


Fig. 6.—Spiral type conveyor fitted to automatic screw machine. *A* Beginning of conveyor trough into which swarf falls. *B* End of conveyor trough where swarf enters chute. *C* Chute outlet. *D* End cam shaft operating conveyor.

the machine where they fall down a chute *BC* into a collecting bin. Work-pieces are prevented from falling into the conveyor by a deflector similar to that described above and illustrated in Fig. 4. The bulk of the swarf produced on multi-spindle automatics can be handled by conveyors of various forms. It is generally more convenient to have the conveyor travelling perpendicular to the axes of the spindles, not parallel as in the case of the spiral conveyor shown in Fig. 6. For this reason it is more effective to have a wide conveyor with a short travel. A plate conveyor can be fitted into a comparatively small space and can be arranged to project from the rear of the machine and overhang the collecting bin.

In the lathe shown in Fig. 7 a copious flow of coolant is used, and the chute and the conveyor have to drain off the chips as they are

removed. A channel is provided below the conveyor for the return of the recovered coolant. Another feature of this machine is that it is inclined backward away from the operator. For this reason surfaces which would normally be horizontal are inclined downward toward the conveyor at the back of the machine. Chips and coolant

Fig. 7.—Heavy lathe fitted with swarf conveyor. Chips and coolant fall down inclined surfaces of machine and chute to conveyor on left of figure.

can be seen falling down these surfaces to the conveyor shown on the left of Fig. 7.

The advantage of these conveyor systems of swarf disposal is their continuity. Such effective and continuous de-swarfing without stoppage of the machine is a direct aid to rapid production as well as to the economic conservation of material.

The swarf from large machines such as wheel lathes and borers not using a large coolant supply can be dealt with as shown in Figs. 8 and 9. The chips produced are usually heavy and not of great length, so that they fall through the open base of the machine. In

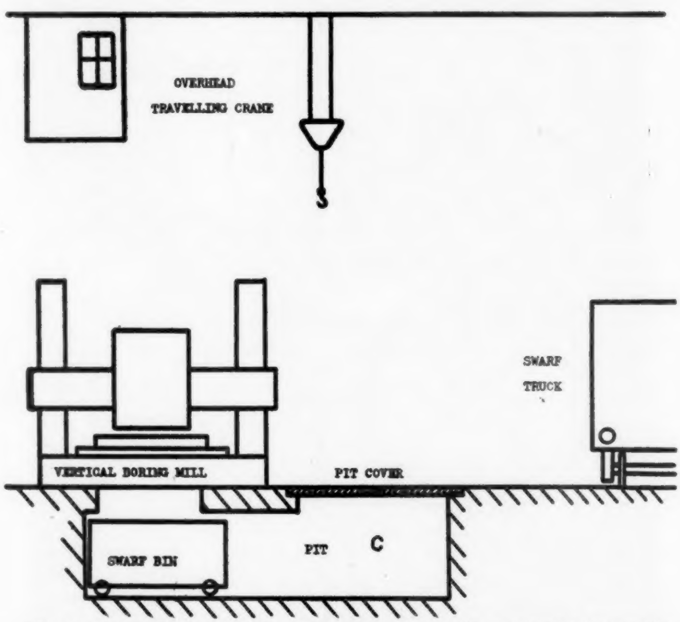


Fig. 8.—Swarf disposal scheme for large boring mills machining locomotive tyres.

the layout shown for the vertical boring mill (Fig. 8) the chips accumulate in the bin below the machine. The bin is on wheels and when it is to be emptied can be drawn along its pit to position *C* which is clear of the machine. A suitable crane such as the overhead crane shown in the layout must be available for handling the heavy work pieces in and out of these large machines, and this crane can

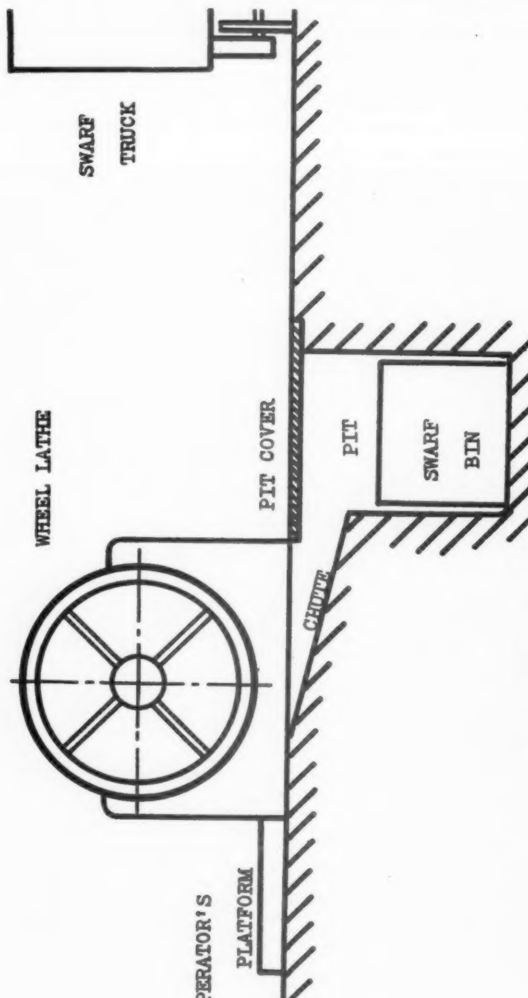


Fig. 9.—Swarf disposal scheme for wheel lathes.

be utilised to lift the pit cover and then to remove the bin. The bin can then be carried away to a swarf dump or large truck such as the rail truck shown in the illustration. In the layout shown in Fig. 9 the chips fall through the base of the wheel lathe and down the chute to a long bin in a pit behind the machine. In this case the

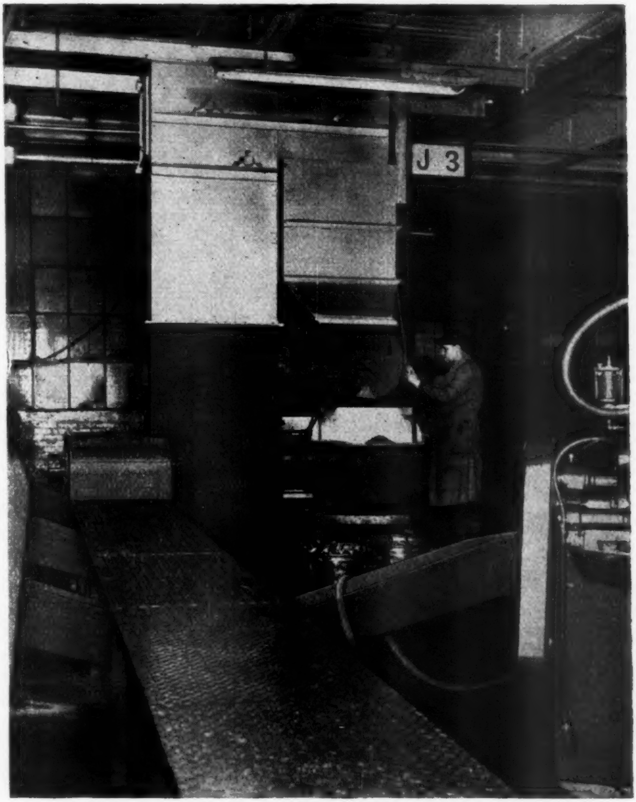


Fig. 10.—Conveyor de-swarfing a battery of automatics.

bin need not be wheeled, for it can be lifted by crane when the pit cover is removed. The bins used in layouts such as shown in Figs. 8 and 9 must be emptied periodically, and it is usually convenient to arrange the bin size to make daily clearing sufficient. It is preferable

for the machine to be idle during the withdrawal of bins, and this makes the mid-shift break a suitable time for daily clearing. The bins from a line of machines can be cleared in a matter of minutes.

If a copious supply of coolant is to be used on such large machines

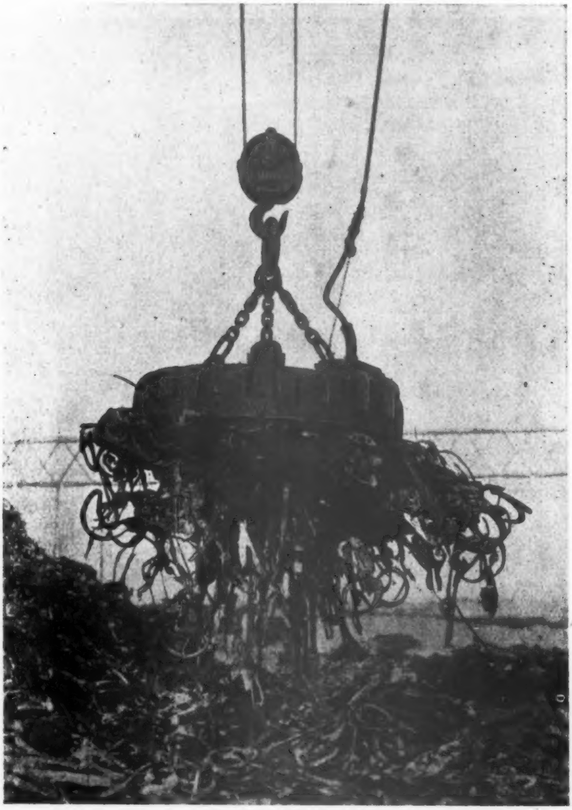


Fig. 11.—Large circular magnet handling swarf and light scrap.

some facilities for straining must be included in the swarf disposal system. In a line of machines constantly operating under such circumstances a conveyor system may be economical, provided the layout of the plant lends itself to this treatment. The chute to the

conveyor and the conveyor itself can then be arranged to permit leakage of the coolant into a collecting channel.

Fig. 10 shows a system of chutes and conveyor de-swarfing a battery of machines. In this installation the conveyor is covered, and the machines which are arranged in line down each side of the conveyor are connected to it by inclined troughs down which swarf and coolant flow. At the end of the conveyor the swarf and coolant pass into a pit from which the swarf is raised by a bucket-type elevator to an overhead hopper. Finally, the swarf is discharged into bins or trucks.

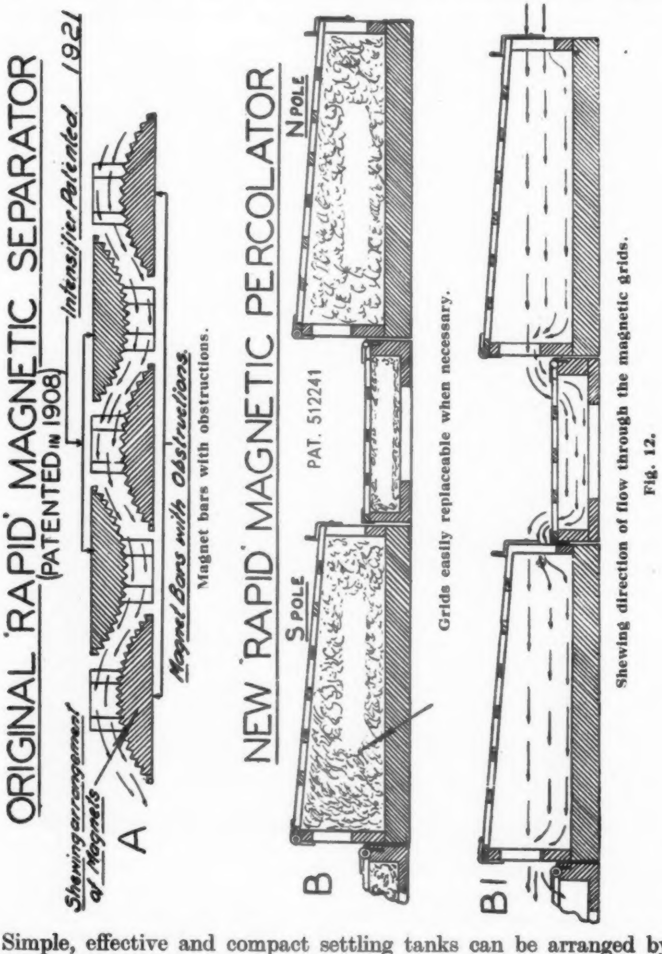
The irregularity of swarf is a factor which often makes mechanical handling extremely difficult, and if large quantities discharged by conveyors or transported by trucks, have to be dealt with in factory yards, etc., the use of lifting magnets may provide a satisfactory solution. Fig. 11 shows a 46 in. diameter lifting magnet handling light scrap.

Separation of Coolant and Swarf.

Coolants are used extensively in many cutting operations, and despite the fact that most machines have strainers in the pan, a large volume of coolant clings to the chips when they are removed from the machine. In order to effect economy of the coolant it is necessary to separate it from the swarf, and where space and time permit this can be done by leaving the wet swarf to drain in a stationary strainer. A much quicker and very effective method is to use a mechanical separator, e.g., centrifugal separator. This machine consists of a revolving inner cylinder and a stationary outer cylinder. The wet swarf is put into the inner cylinder by hand or crane, depending on the quantity of swarf and the capacity of the machine. The machine is closed and the inner cylinder rotated so that the oil is flung outwards and passes to the outer cylinder where it is collected. The cleaned swarf is then removed and the process repeated. The principle of these centrifugal machines is illustrated in Fig. 13 and a battery of separators in use is shown in Fig. 14. Over 500 gallons of oil per day are recovered by these three machines which are equipped with overhead runways and lifting tackle for handling the baskets during loading and unloading.

The separation of swarf and coolant involves not only the removal of as much oil as possible from the main bulk of the swarf, but also the elimination of the finer swarf from the cutting fluid. Proper control of swarf is not only important as a step to the recovery of the material, but also as a means of reducing the nuisance value of the swarf, which may cause damage and delay. Perhaps the most frequent source of trouble is the clogging of the coolant pumps. It is essential to have correct strainers at machine outlet and pump

intake. Plate and box type strainers are effective against coarser swarf, but very fine swarf such as is produced by skiving and shaving operations on turning autos, or by grinding, requires a settling tank.



Magnet bars with obstructions.

Grids easily replaceable when necessary.

Shewing direction of flow through the magnetic grids.

Fig. 12.

Simple, effective and compact settling tanks can be arranged by using an appropriate series of baffles. Coolant which has passed through strainers and settling tanks is comparatively clean and

quite satisfactory for further use in ordinary machining operations, but if absolute purity of cutting oil is required mechanical separators should be used. Machines operating on the same principle as the centrifugal separator described above are available for cleaning the oil so completely that it can be used again even on comparatively delicate operations.

Besides these various mechanical methods of removing metallic particles from cutting oil there is a very effective magnetic method. two variations of which are illustrated in Fig. 12. The method consists of causing the oil to flow through passages in which magnetized obstructions collect any magnetic material suspended in the oil. In practice the channels through which the oil flows slope so that the flow is maintained by gravity. In the layout shown in Fig. 12 A

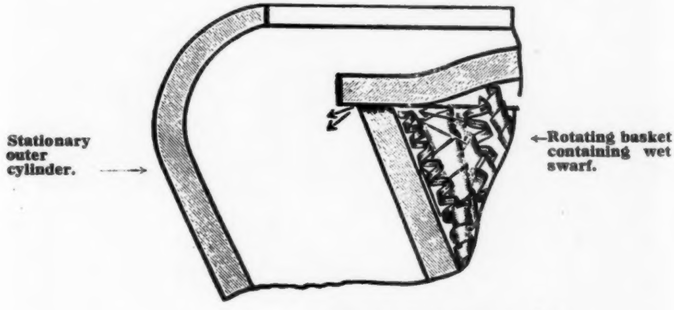


Fig. 13.—Principle of centrifugal separator.

the oil passes through a winding channel into which magnet bars protrude and gather the passing metal particles. A much better layout is shown in Figs. 12 B and 12 B1. Here the oil passes through a series of perforated boxes filled with fine metal grids, designed to have the maximum length of edges, for it is to magnetised edges that suspended particles most readily cling. Fig. 12 B shows how the magnetic grids are arranged, and Fig. 12 B1 shows the winding path which the oil is compelled to take in passing through the grids. The perforated magnet boxes containing the grids are arranged in series in the liquid channel and it is only necessary to raise the hinged lids of these boxes in order to remove the loaded grids for cleaning. The type of work for which these machines are particularly useful is the separation of metallic particles from the coolant used during operations such as thread grinding.

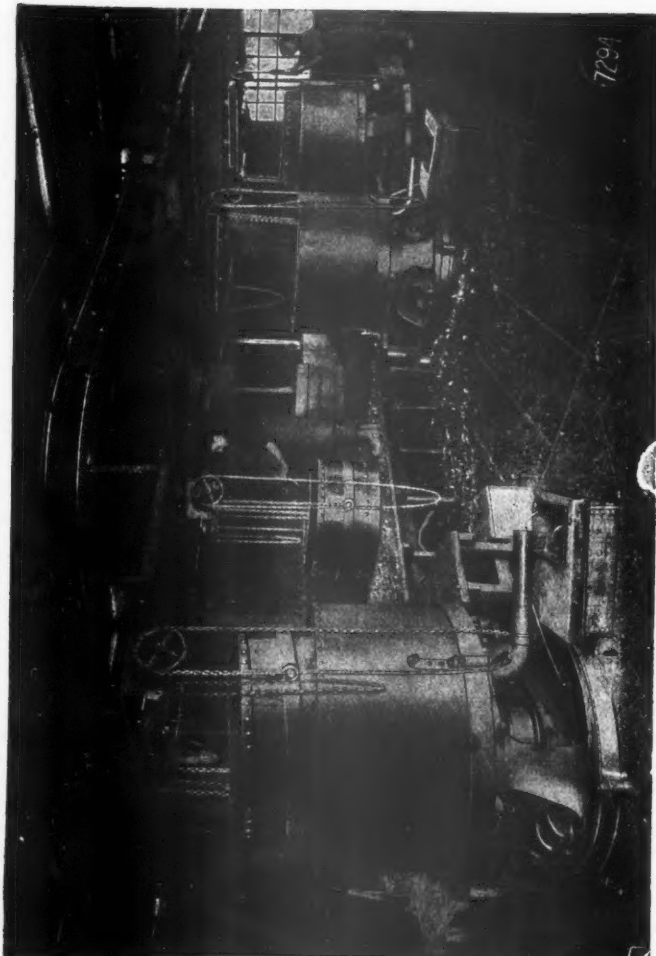


Fig. 14.—Three centrifugal separators in use. Basket of middle separator removed to loading platform. Note oil outlet at base of separators.

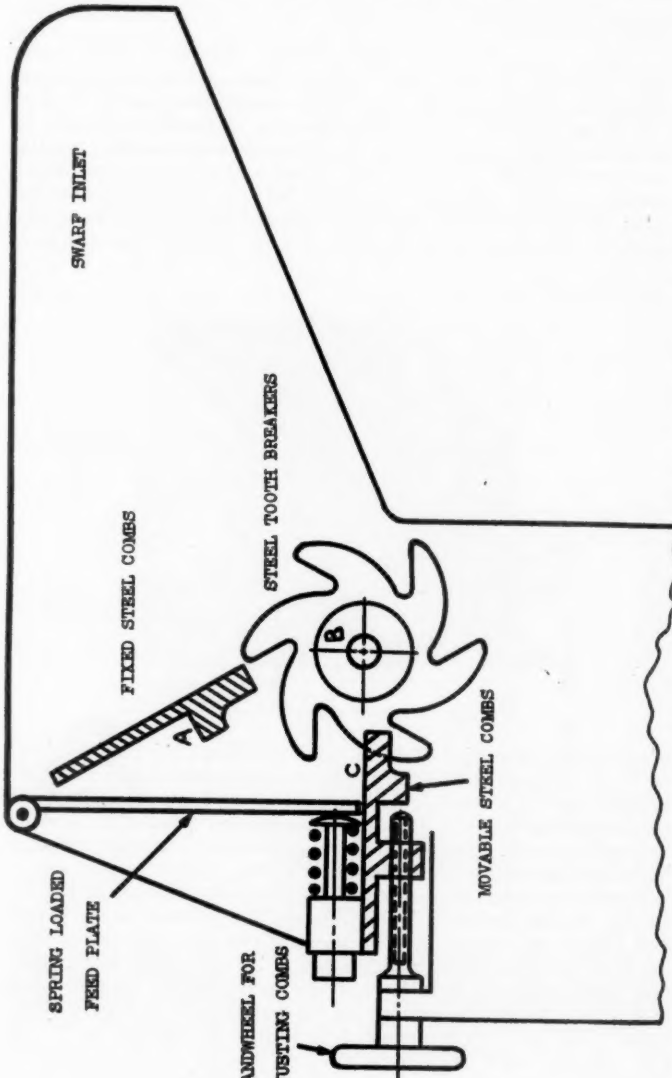


Fig. 15.—Diagram showing mode of operation of swarf breaking machine.

Swarf Breaking.

Some swarf such as that produced when turning or drilling steel takes the form of long curled strips. These spirals often become difficult to handle, and if much of this coarser swarf has to be dealt with it is desirable to have it broken up. A machine suitable for swarf breaking is shown in Fig. 15. It consists of a series of rotating breakers *B*, the teeth of which pass between the teeth of a stationary cutting comb *C*. The swarf is carried between the rotating breaker teeth, past a fixed comb *A* which regulates the feed to the cutting comb *C*. The position of the cutting comb is adjustable by a hand

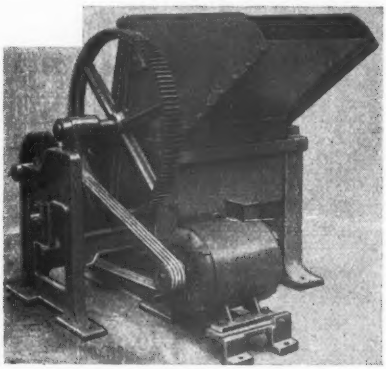


Fig. 16.—Swarf-breaking machine.

wheel to suit the chips dealt with. A spring-loaded friction clutch drive can be arranged to slip at any predetermined load so that the introduction of a solid article such as scrap work piece, key, file, etc., stops the machine without damaging any part of the gearing or breaking teeth. The general layout of this swarf-breaking machine, including the texrope drive, is shown in Fig. 16.

Another powerful type of swarf breaker is that shown in Fig. 17. In this crusher the swarf is fed in heaps into the side of the hopper and falls on to the rotor. The teeth of the rotor are pivoted but are held in their outer crushing position by centrifugal force. They grip the swarf and force it past the spring-loaded breaker block and then through the grid which surrounds the lower part of the rotor. The path of the swarf is indicated by dotted lines. The grid bars are made of high carbon steel and the crushing elements of heat treated cast alloy steel with wear resisting tips welded on.

Instead of teeth the rotor can be fitted with crushers of the clover leaf form shown on the left-hand side of Fig. 17. These manganese steel rings are also maintained in their outer crushing position by centrifugal force. The rotor is shown separately in Fig. 18. Ample provision is made in this crusher to avoid damage which may be incurred by the inclusion of " tramp metal " in the swarf. The crusher teeth or clover leaf steel rings are free to recede into the rotor as shown at *A* Fig. 17 if they come into contact with solid metal having sufficient resistance to overcome the centrifugal force which maintains the crushing elements in their working position. Moreover, the breaker plate is spring-loaded to prevent excessive shock at that point. In addition to these safety features there is a special built-in " tramp metal " catcher, and in pulley driven mach-

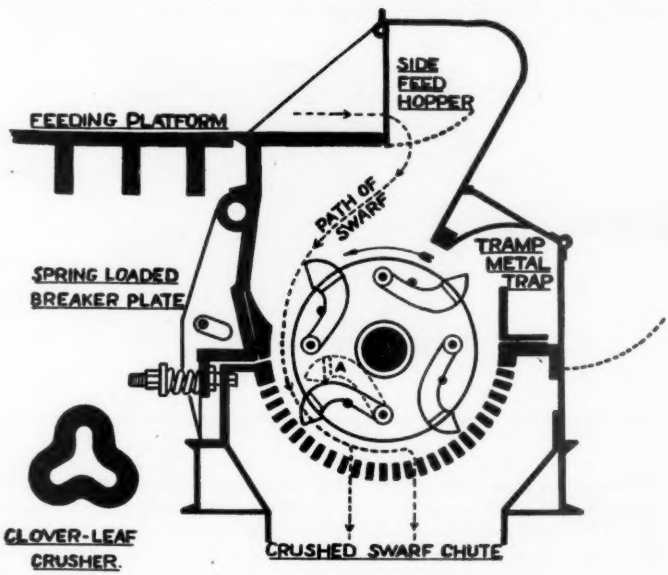


Fig. 17.—Swarf Crusher.

ines a shear pin device is also included. Where it is more convenient a top feed hopper can be arranged to replace the side feed hopper shown above. Some form of hopper closed by a flap is essential because, when there is only a small quantity of swarf in the machine there is a tendency to fling this out and endanger workers. The speed of these machines varies from 500 to 900 r.p.m. and the power

consumption from 25 h.p. for a machine crushing one ton of chips per hour to 75 h.p. for a machine crushing six tons of chips per hour.

In addition to separate chip breaking machines such as those described above there are also mechanisms for chip breaking which are built into machine tools. For example, some special automatic machines for rapid turning incorporate devices for breaking and baling swarf which is immediately delivered in a compact form ready for transport.

Swarf Sorting.

In some workshops where very varied work is encountered, it becomes impracticable to keep all swarf of different materials separate, so that mixtures of brass, steel, aluminium, cast iron, etc.,

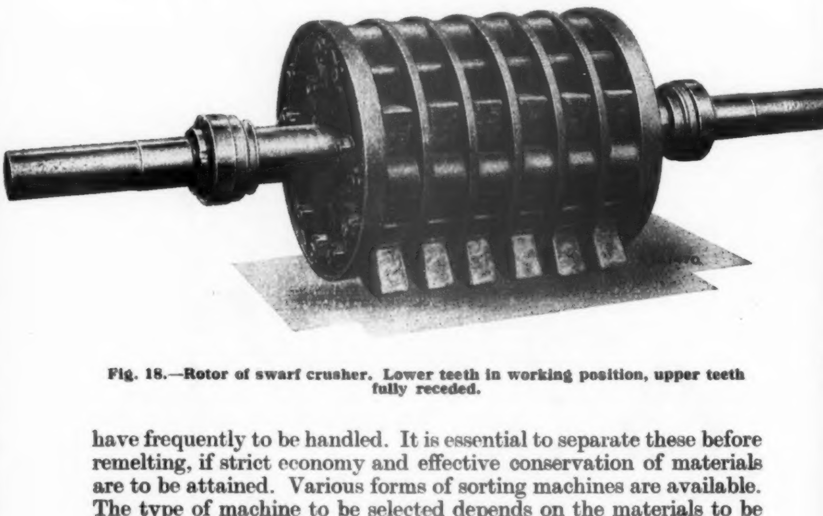


Fig. 18.—Rotor of swarf crusher. Lower teeth in working position, upper teeth fully receded.

have frequently to be handled. It is essential to separate these before remelting, if strict economy and effective conservation of materials are to be attained. Various forms of sorting machines are available. The type of machine to be selected depends on the materials to be separated, the approximate percentage of iron and steel content of the mixture, the approximate size of the swarf handled, and the rate of separation required. Reliable Universal machines are available which will effectively separate the most varied mixtures, but if the material to be handled is known to consist of small chips, or to be of powder form, or to contain not more than, say, 10% iron and steel, such information facilitates the selection of simpler machines than those required for the more general tasks.

A machine suitable for the most varied separation is shown in

Figs. 19 and 20. This magnetic separator is designed to deal with coarse or fine swarf and to remove the iron content whatever its percentage of the whole. The machine consists of a belt in which a large number of steel inserts are arranged in staggered rows. The belt passes over two pulleys set in an adjustable frame so that the inclination of the straight portion of the belt can be arranged to suit the materials being separated. A series of stationary electro-magnets of alternate polarity are located beneath the length of belt

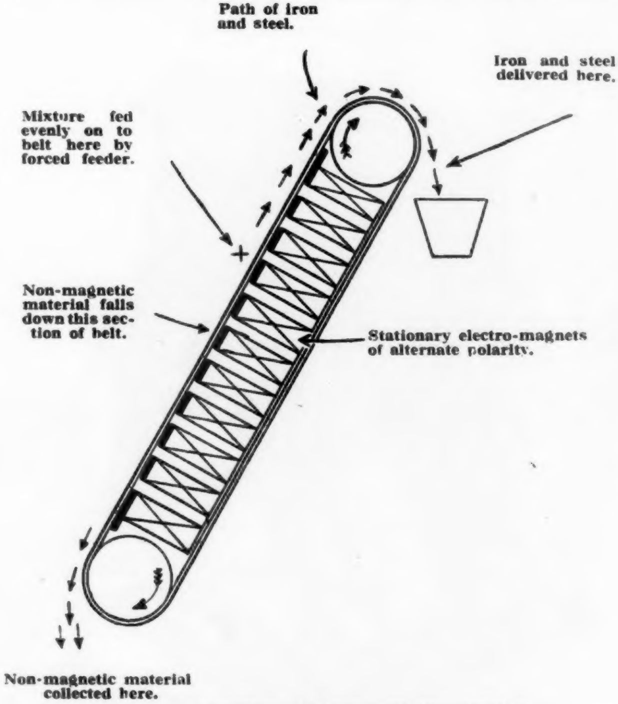


Fig. 19.—Operation of electro-magnetic separator.

moving upward, so that inserts passing through the field are subject to alternating polarity. Iron chips attracted to the magnetised inserts jump from one insert to the next as the belt moves over alternate magnetic poles. This jumping action disturbs the material and thus frees non-magnetic particles which fall down the belt chute, while iron and steel are carried to the top of the chute. As

the belt passes over the upper pulley the inserts lose their magnetism, and the extracted iron falls by gravity into the upper container. Thus the mixture is fed to the belt chute at X, the iron is collected at the top and the remainder at the bottom. The capacity of these machines is varied by varying the width of the belt. Since the process of separation does not involve a vibrating chute, the framework is not subject to vibration stresses. This not only ensures long life by eliminating vibration of the magnet coils and ball-bearings, but also obviates the necessity of foundations or even of bolting

Fig. 20.—Electro-magnetic separator.

the machine down, and facilitates modification to make the machine portable. The photograph (Fig. 20) shows the machine with a special forced feeding mechanism. This feeder is designed to overcome the troubles caused by choking of the ordinary hopper and oscillating

Fig. 21.—Twin-drum separator.

tray-type feeder. At the entrance to the feeder is a revolving pronged roller which continually disturbs the ingoing mixture. Beneath this pronged roller is a hollow feed roller. The required rate of feeding is obtained by varying the width of the adjustable feed slots in this roller. At the front and rear of the feeder are spring flaps which open to allow the passage of large pieces of solid material, thus avoiding the possibility of damage to delicate machines.

A simpler type of machine suitable for separating iron and steel from non-magnetic materials consists of powerful electro-magnets enclosed in a brass drum. The magnets which create a strong magnetic field round the front half of the drum remain stationary, while the drum itself rotates. The mixture is fed at a uniform rate from the hopper above the drum, and separation is effected by the non-magnetic material falling from the drum at the front of the machine and passing down the diverting chute, while the iron and steel cling to the drum until they are released in the demagnetising region at the back of the machine. Experience has shown that the most convenient drum diameter is 14 in., and the output of the single drum machine is about 2 cwt. per hour for each 6 in. width of drum, the corresponding power consumption being approximately 100 watts. The precise output is of course dependent upon the nature of the mixture. The hopper is of the oscillating tray type. About 95% of the magnetic material is extracted from the mixture by passing over the drum once, and if more complete separation is required the material should be retreated, or a machine having two drums should be used (Fig. 21). This drum type of machine is particularly suitable for the separation of mixtures containing more than 3% iron and steel. It is not advisable to use the separator for mixtures having an iron content of less than 3% because the thickness of the brass drum and the clearance between the drum and the magnets reduce the pull on the passing iron and steel chips and make the extraction of fine particles very difficult.

Many types of magnetic separating drums and pulleys exist, and it is essential to appreciate the fundamental differences between the various kinds if a correct choice is to be made. The most important difference is that materials separated by a magnetic pulley (Fig. 22*a*) do not come into contact with the pulley because of the intervening belt, whereas materials treated by a magnetic drum (Fig. 22*b*) do come into direct contact with the drum surface.

The entire cylindrical face of a magnetic pulley (Fig. 22*a*) is surrounded by a constant magnetic field. The mixture to be separated is carried on a belt, which discharges the non-magnetic material as it passes down the outside of the pulley, while the magnetic material clings to the belt and is only released when the latter parts

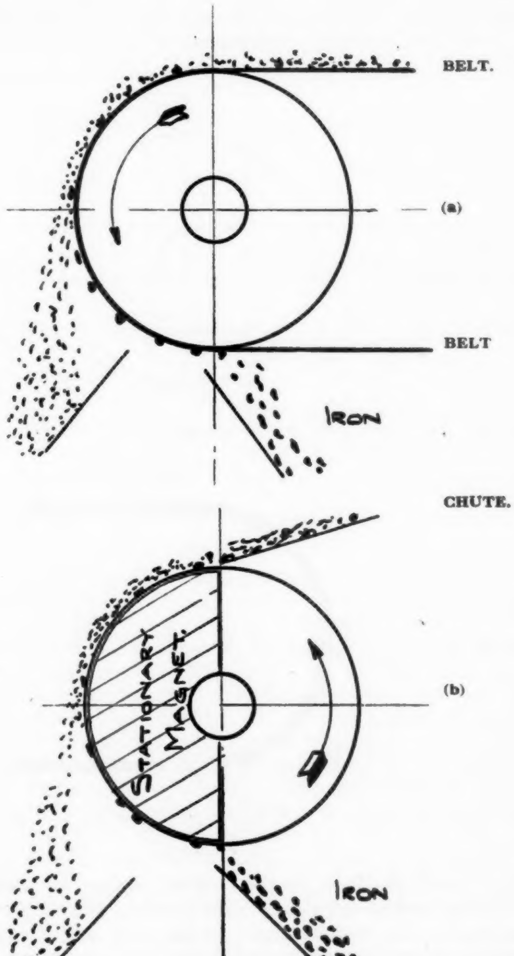


Fig. 2[illegible].—Showing difference between (a) magnetic pulley, (b) magnetic drum.

from the pulley on the lower side (Fig. 22*a*). A great disadvantage of the magnetic pulley is that even the thinnest belt prevents the extracted iron reaching the strongest part of the magnetic field. It is obvious that with this magnetic system it is impossible to

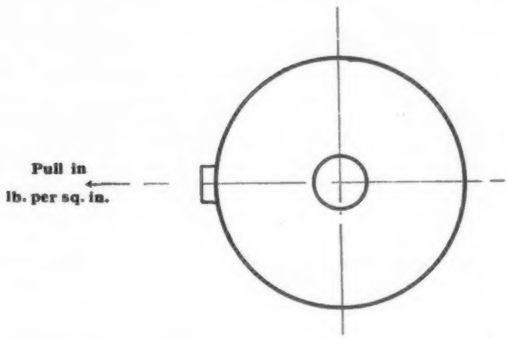


Fig. 23

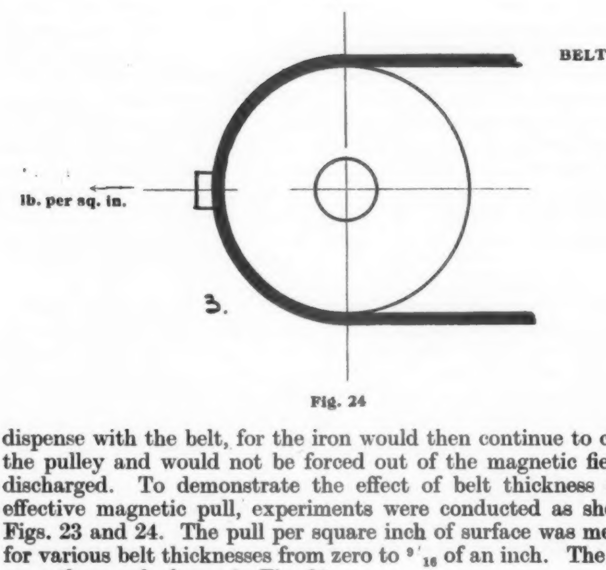


Fig. 24

dispense with the belt, for the iron would then continue to cling to the pulley and would not be forced out of the magnetic field and discharged. To demonstrate the effect of belt thickness on the effective magnetic pull, experiments were conducted as shown in Figs. 23 and 24. The pull per square inch of surface was measured for various belt thicknesses from zero to $^{9}/_{16}$ of an inch. The results gave the graph shown in Fig. 25.

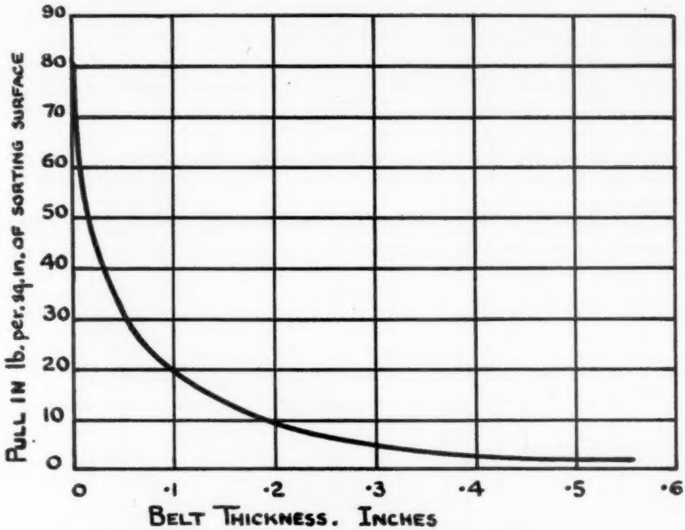


Fig. 25.—Reduction of magnetic pull due to increasing belt thickness.

There are several types of magnetic drums. The most usual is that described above (Fig. 22*b*), in which a stationary magnetic field extending round half the drum circumference allows the non-magnetic material to fall as it passes through the magnetic field and releases the iron and steel as it passes to the non-magnetic region. One disadvantage of this simple type of drum is that a piece of non-magnetic material which happens to be between a piece of iron and the drum surface as it enters the magnetic field may be trapped and held until the iron and with it the trapped material fall off in the non-magnetic region. This difficulty has been overcome in some types of drum separators by replacing the constant magnetic field by a series of fields of alternating polarity. Thus, as the scrap mixture is carried through the magnetic region, the iron and steel turn over and over as it passes alternate north and south poles, and non-magnetic material is liberated and falls from the drum.

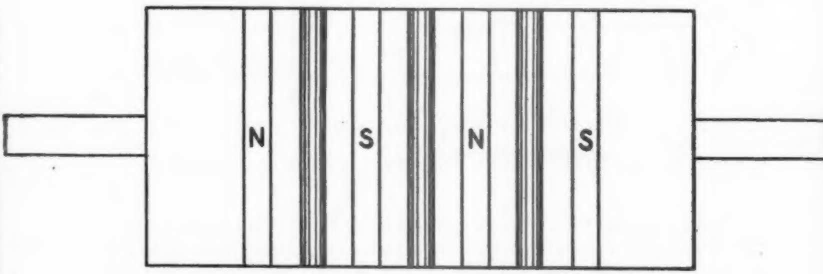
Another factor which impairs the performance of some types of magnetic pulleys and drums is the presence of neutral zones. If instead of having alternate poles spaced around part of the circumference of the pulley and each extending along the entire width of the pulley surface, the poles are spaced along the axis as shown in Fig. 26,

then the neutral zones created will extend round the pulley circumference as shown by the shaded portions of Fig. 26. The effect of these neutral zones is more serious when handling fine grain mixtures, and in such cases care should be taken to select a pulley specially designed to overcome the difficulty. One method which has proved very successful is to replace the brass pulley by a steel pulley and adjust the pulley thickness and location of the magnetic system so that the magnetic flux lies more or less evenly over the surface of separation.

The vibrating trough electro-magnetic separator (Figs. 27 and 28) is specially designed for the separation of mixtures in which the iron and steel content is less than 3% and which take the form of very small chips or powder. As stated above, such materials are difficult

A MAGNETIC PULLEY

CONSTRUCTED ON GENERALLY ACCEPTED PRINCIPLES.



THE SH/ \ LINES REPRESENT THE "NEUTRAL SPOT."

Fig. 26.

to handle on drum-type machines and cannot easily be fed down stationary chutes. The machines consist of a vibrating inclined tray made of non-magnetic material and carrying steel bars which are magnetised by induction from stationary primary coils situated below. The mixture to be separated is fed into the hopper at the top of the inclined trough and slides evenly over a series of magnets which oscillate in the direction of the flow. The iron and steel particles cling to the powerful magnets, while the non-magnetic material passes down the trough and is discharged at the foot. When the magnets are fully loaded the machine must be stopped while the iron and steel is removed from the trough. It is for this reason that the machine is not recommended for the separation of mixtures containing more than 3% iron and steel which would result in quick loading of the magnets and in frequent stoppages for cleaning.

The minimum number of magnetic units to give good separation is three, but additional units can easily be incorporated if more complete separation is required. The output of the machine is dependent on the width of the trough, which is usually between 6 in.

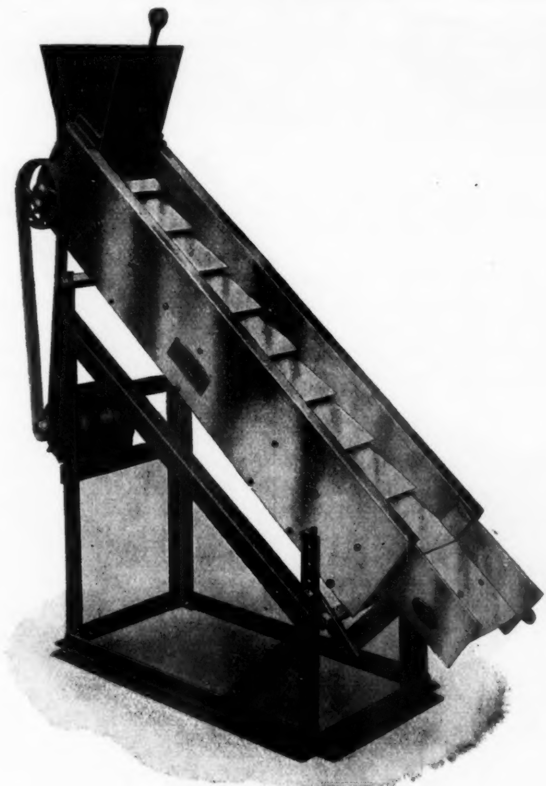


Fig. 27.—Vibrating trough electro-magnetic separator.

and 24 in. The tray and magnet bars are the only oscillating parts; the remainder of the magnetic system and the trough sides being free and stationary. This not only reduces wear of bearings and coils but also obviates the necessity of heavy foundations, so that

the machines can readily be made portable. The general form of the chutes used in these separators is illustrated in Fig. 28, which shows the chute of a stationary waterfall separator with the side removed. In selecting a magnetic separator for a particular job recriminations and unreasonable maintenance charges can be avoided by ensuring that vibrating parts of the machine have adequate bearing surfaces, and that coils are not subjected to excessive vibration.

Fig. 28.—Section of separator chute.

A problem of separation which frequently arises is where the metals to be separated are fixed together. For example, sub-assemblies of small electrical fitments frequently contain brass and steel, and when such assemblies are rejected by an inspection department they are frequently deposited in bins of assorted scrap work pieces. Such scrap is often sorted by hand, and if the scrap is left to accumulate before sorting it soon becomes tarnished, so

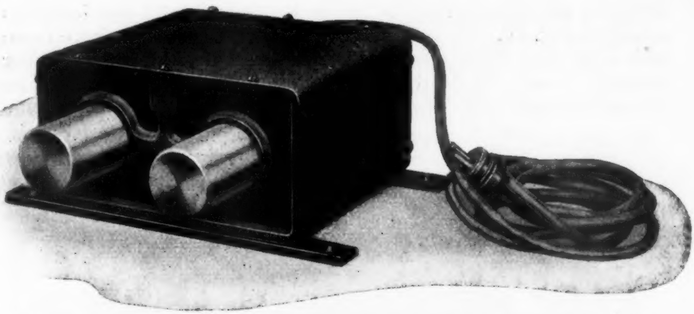


Fig. 29.—Bench magnet for scrap metal sorting. This Magnet can also be provided with poles at each end so that one magnet will suffice for two sorters. It can also be arranged for suspending over bench.

that the difficulty of distinguishing one metal from another is greatly increased. However, by the aid of a suitable magnet the presence of even small steel screws in large brass assemblies or of broken drills or taps in brass or aluminium work pieces are quickly detected. Such magnets may be suspended above the work-bench,

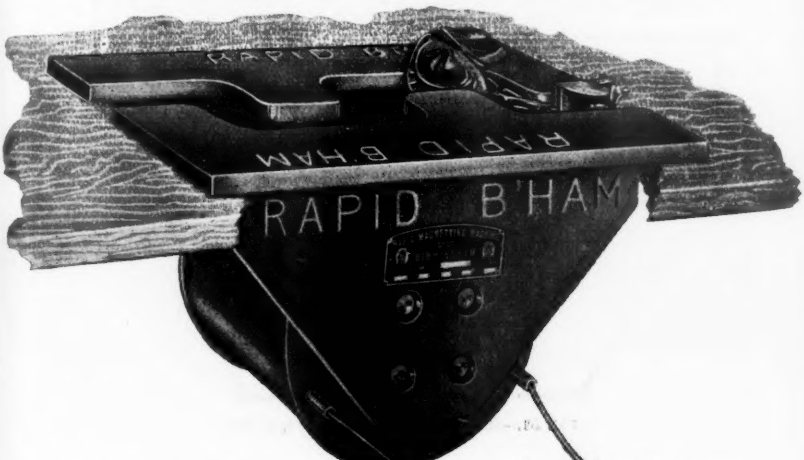


Fig. 30.—Scrap-sorting magnet for testing and detecting hidden iron in all classes of non-ferrous scrap. Designed for fixing flush in bench.

stand on the bench (Fig. 29), or be fixed flush with the bench as shown in Fig. 30. Where large quantities of such scrap have to be sorted the flush type of magnet is most suitable, but where smaller quantities are to be dealt with the initial expenditure may not be warranted, and one of the other types may be used. Such extreme

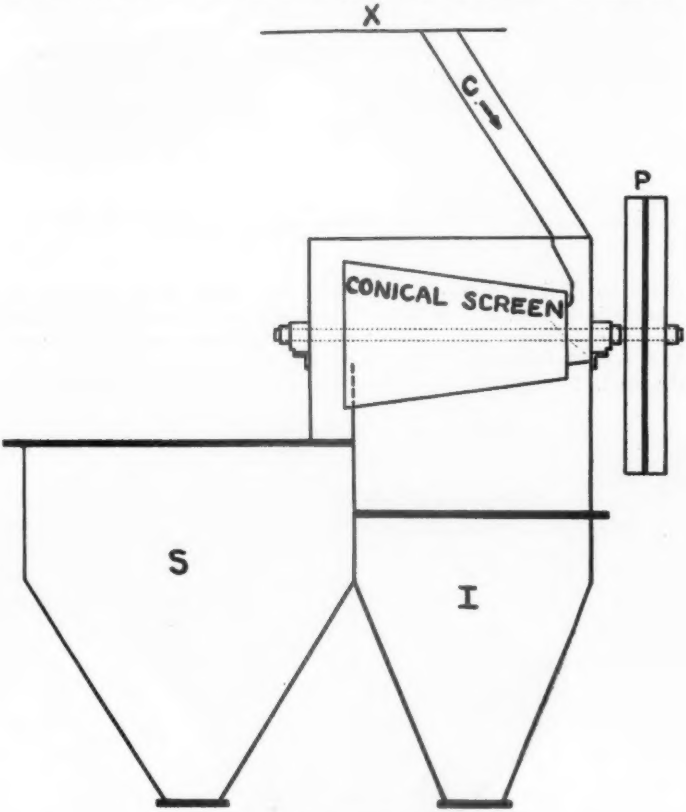


Fig. 31.—Rotating conical screen separator.

care for the elimination of the smallest quantities of iron and steel from brass scrap may seem unnecessary, but the value of non-ferrous scrap increases sharply as the last few percent. of iron and steel are extracted.

Another machine which roughly separates cast-iron and steel chips is shown in Fig. 31. It consists of a revolving conical screen into which pulverised iron and steel chips are fed through a chute *C*. The chips enter the narrow end of the screen, and as they roll and fall toward the large end, which is open, most of the cast-iron passes through the screen into the first hopper *I*. The steel is not reduced to such fine grains by the pulverising process, and consequently does not pass through the screen, but is delivered out of

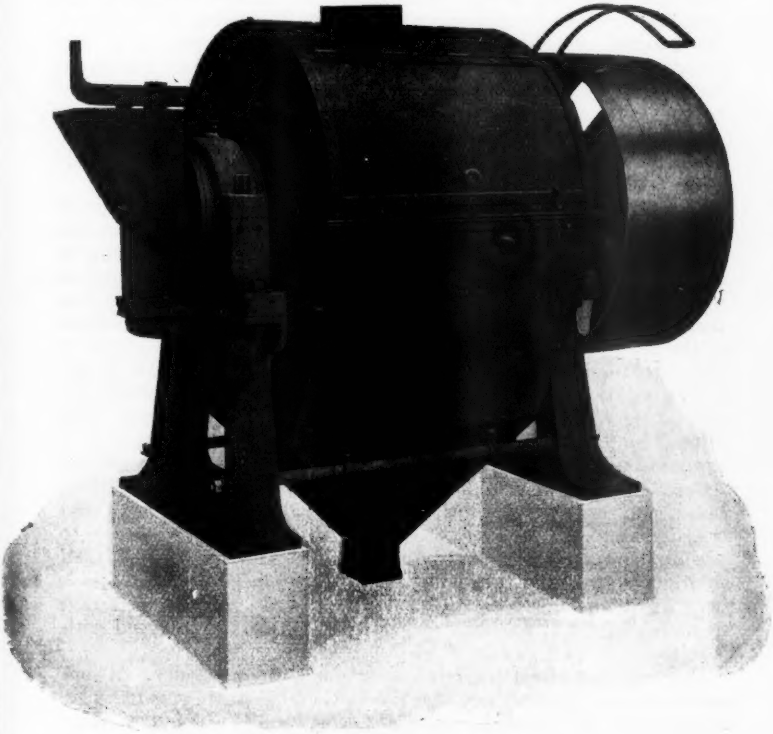


Fig. 32.—Ball mill and separator.

the open end to the second hopper *S*. Since the sole basis of separation is the difference of chip size after pulverising, it is obvious that some steel will fall into the cast-iron hopper and vice versa, but in most cases the separation is sufficiently complete. The

feeding point X at the top of the chute can be located at floor level, and the screen and hoppers arranged in the storey below. The screen is driven through a pulley P fixed to the end of the shaft.

It is sometimes necessary to recover metal chips from the ashes, sweepings, etc. Iron and steel can be almost completely extracted by the magnetic separators already described, but where brass, aluminium and other non-magnetic material has also to be extracted the cinder mill shown in Fig. 32 can be used. The mixture is fed through the hopper shown on the left of the illustration into a steel grinding drum where a number of loose hard metal balls commence the process of reducing the non-metallic material to dust. The grinding is performed dry, and the dust passes through the perforated scouring drum, and is discharged through a polygonal set of sieves to the lower part of the machine. The recovered metal is then removed from the drum ready for further sorting by magnetic separator if the mixture contains magnetic and non-magnetic materials.

An effective method of separating aluminium from other metals is by flotation. The separator consists of a large tank containing a solution which has a specific gravity greater than aluminium or Duralumin or the alloy to be separated. The mixture of chips is immersed in the solution so that chips with a specific gravity less than the solution float at its surface, while others sink to the bottom of the tank, where they are caught in a perforated pan. Perforated ladles are used to take the floating aluminium chips from the surface of the solution, and to transfer them to washing vats where the separating solution which clings to the chips is removed. The diluted solution resulting from this washing process is recovered by evaporation, which continues until the required density is regained. After removing the aluminium the pan containing the iron, steel, brass, etc., is raised from the bottom of the separating tank and transferred to the washing vat. The washed chips are passed on to one of the magnetic separators already described, and the diluted solution recovered by evaporation. This method of separation is very quick and inexpensive if the processes are properly arranged so that separation, washing, and recovery of solution proceed with continuity and efficiency.

In many workshops mechanical sorting is not necessary. Where machines are engaged on the production of large quantities of components of the same material, it is usually easy and quite economical to keep the swarf of that material separate from swarf of other materials.

Preparation for Storage, Transport or Remelting.

After the required sorting and separation of oil, etc., from the swarf, problems of storage and transport arise, and finally the

material has to be put into a form suitable for introduction to the remelting plant. Again the most effective method of handling is dependent on the form and quantity of the swarf.

Cast Iron.

Cast-iron swarf created by such machining operations as turning, planing, milling, etc., is usually in the form of small chips. The

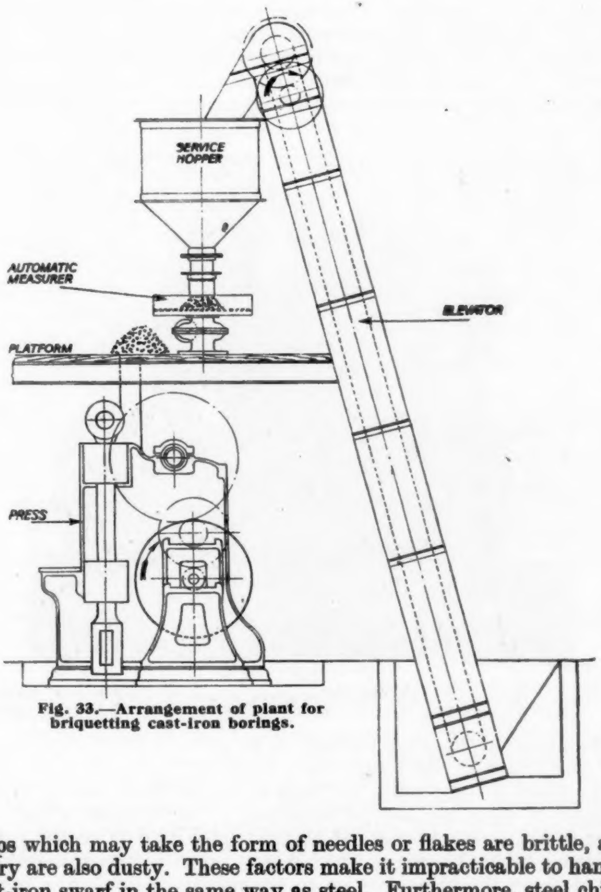


Fig. 33.—Arrangement of plant for briquetting cast-iron borings.

chips which may take the form of needles or flakes are brittle, and if dry are also dusty. These factors make it impracticable to handle cast-iron swarf in the same way as steel. Furthermore, steel chips,

however small, can be utilised in electric furnaces, but in the case of cast iron oxidation and loss in the blast make it extremely uneconomical to feed loose swarf to the Cupola. Two methods by which these small chips can be successfully remelted are by (1) packing in containers, (2) briquetting.

The disadvantages of packing in containers are the cost of the containers, and the fact that loss due to oxidation and in the blast still occur to some extent, dependent on how tight the chips are packed in the container. Fortunately most of these disadvantages can be overcome by the process of briquetting, whereby the swarf is compressed into blocks of convenient size and with a density of at least 70% that of the solid material. Cast iron lends itself so well to the briquetting process that no binder is required. Fig. 33

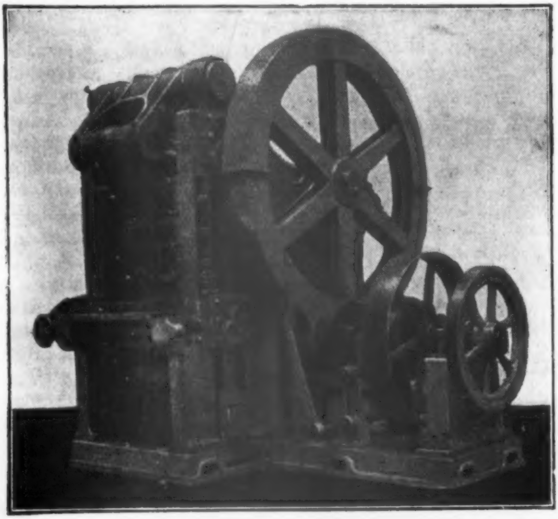


Fig. 34.—Briquetting Press.

shows the arrangement of a complete briquetting plant, and Fig. 34 is a photograph of the Toggle press alone.

The swarf is tipped into the boot of the elevator (Fig. 33) by a labourer or by a mechanical conveyor. The elevator carries the swarf to the service hopper, which discharges it on to an automatic measuring table. The press, which is thus fed with chips at a uniform rate, delivers the briquettes on to the machine table. The power

consumption of the machine is approximately 12 h.p. when converting about 1 ton per hour into 600 to 700 briquettes. Where the cast-iron chips are too coarse for feeding to the briquetting press, a tumbler barrel may be used. One end of the barrel is open so that the chips can be thrown in, to be reduced by a roller until they pass through the perforations of the screen. A chute guides the reduced chips from the tumbler barrel to the elevator boot of the briquetting machine.

Steel.

Steel swarf or sheet scrap can usually be baled or bundled, although in many workshops swarf such as turnings and borings are handled loose by the use of steel bins, barrows, trucks, etc. Some firms, especially those producing irregular, cumbersome sheet-metal scrap resort to hand baling. Generally the bundles produced by this method are not so compact or uniform as those from bundling and baling machines, nevertheless, if properly organised the system of hand baling can be made quite efficient.

For plants where machine baling is preferred, reliable baling and bundling presses capable of dealing with a wide range of metal scrap are available. Machines ranging from the simple press shown in Fig. 35, to heavy power-driven presses, may be used according to the condition and quantity of material to be dealt with. The operation of the hand press (Fig. 35) is effected through a lever and a ratchet which actuate a rack and pinion. The size of the finished bales is approximately 9 in. by 10 in. by 8 in., the free scrap having occupied a maximum space of 9 in. by 10 in. by 48 in. The power driven presses which are generally hydraulically operated usually compress the scrap in two stages, using rams at right angles and often include a third ram for ejecting the bale. The power consumption is approximately four h.p. input to the press per cwt. of bale, and machines are available which handle bales of over three cwt. and compress the scrap to less than one-third the space occupied before baling. Material which is reduced to a compact form is not only handled and stored more easily, but can readily be introduced to the remelting furnace. Some ferrous scrap such as fine filings, etc., is so small that it is difficult to handle by any of the foregoing methods. An effective way of dealing with this is to fuse the particles together until pieces sufficiently large for introduction to the furnace are formed. The whole process can be performed automatically and at high speed if an efficient sintering plant is utilised. Such plant includes continuous uniform feeding of the fine chips to a conveyor. The conveyor carries them past a flame which effects the required fusion and leaves a sintered material that can be used in the production of high-grade iron.

Non-ferrous Metal.

Non-ferrous swarf can be treated either in the same way as steel or, as is more usually the case, can be dealt with in machines of the type used for cast iron, for most non-ferrous swarf is easily briquetted. In addition sacks are sometimes used for the storage and transport of non-ferrous swarf.

The ultimate object of the efficient handling of swarf and scrap metal is effective recovery of the material. The nominal value of of the scrap may seem small, but the recovered material is of great value, especially under the present conditions of unlimited demand and restricted supply. The final stage of recovery is the actual remelting which cannot be effected without certain losses, nevertheless by proper preparation, including compact baling or briquet-

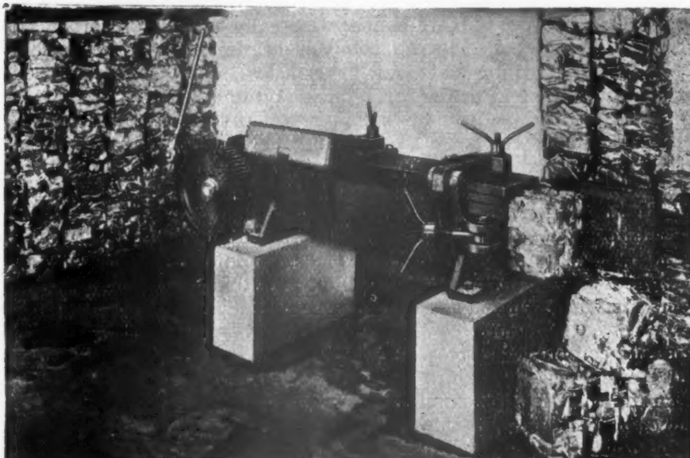


Fig. 35—Baling Press.

ing, some of the chief sources of loss such as oxidation are considerable reduced. By the use of a well-arranged cast-iron briquetting plant chips can be briquetted at a cost of less than 7s. per ton, and if included as 10 to 20% of the cupola charge it is possible to save up to £1 per ton of melted iron. The briquettes are so compact that oxidation is limited, although the density and structure are such that the graphite is burnt off just above the fusion zone. The carbon lost is not entirely replaced during fusion, so that the final result is a reduction in carbon which permits the production of high-grade castings at a considerably reduced cost.

Aluminium.

A reduction in the loss of any material, whether cast iron, steel or non-ferrous metal, is always desirable, but to-day when aluminium is so vital to our air strength, no effort should be spared in conserving every scrap of this precious metal. It is therefore imperative that all possible steps be taken to prevent the excessive oxidation to which aluminium is prone. The scrap should be well cleaned by degreasing, roasting to remove foreign organic matter, etc., and then baled or briquetted. The presence of moisture in the furnace is particularly harmful, and special care must be taken to ensure that bales are perfectly dry before they are introduced into the furnace. The prepared scrap must be completely submerged in molten metal, so that it is not affected by the oxygen of the atmosphere. Small scrap must not be melted down in the pre-heating chamber used in the open-hearth furnaces to prevent cooling of the melt by incoming metal. Any fluxes used should also be introduced directly into the molten metal to ensure that they do not act as a medium for the introduction of moisture. If all these precautions are taken the loss due to oxidation can be reduced to between 1.5 and 3%, which compares favourably with the 1 to 1.5% when melting ingots. To avoid the uncertainty regarding the precise composition of scrap it should be melted in the largest convenient quantities and cast into ingots. Accurate analysis is then possible and effective alloying facilitated.

ACKNOWLEDGEMENTS.

The author is pleased to record his appreciation of the helpful suggestions made by Mr. H. C. Holmes, D.L.C., and of the assistance of the following firms who have supplied blocks and photographs: The Rapid Magnetting Machine Co. Ltd., Birmingham; William Johnson & Sons, Ltd., Leeds; Herbert Morris, Ltd., Loughborough; John Lang & Sons, Ltd., Johnstone; A. C. Wickman, Ltd., Coventry; W. B. White & Sons, Ltd., Colne; J. W. Jackman & Co. Ltd., Manchester; Greenwood & Batley, Ltd., Leeds; Alfred Herbert, Ltd., Coventry; Manlove, Alliott & Co. Ltd., Nottingham; British Jeffrey Diamond, Ltd., Wakefield; and *Machinery*.

THE EFFICIENT UTILISATION OF LABOUR UNDER WAR CONDITIONS

Correspondence between Sir Alfred Herbert, K.B.E., Hon. M.I.P.E. and the Institution.

DUNLEY MANOR,
WHITCHURCH, HANTS.

THE SECRETARY, November 26, 1940.
Institution of Production Engineers, LONDON.

DEAR SIR.

I have read with interest the memorandum on the utilisation of labour under war conditions. Many of the suggestions are helpful, but it does not appear that the problem of training unskilled labour, both male and female, has received sufficient attention. There are still masses of unemployed of both sexes; there are many thousands of women who have not yet come into industry, but are willing to do so if given the opportunity, and all branches of mechanical engineering abound with work of a simple repetition character, which can be carried out quite well by this new labour after an amazingly short period of training.

Reference is made to the training centres of the Ministry of Labour. These training centres, of which there are a considerable number, have served a valuable purpose up to a point, but the tendency in the past has been for the courses to extend over too long a period in an attempt to produce engineers. I think at last the Government has realised—

(1) That the number of these centres must be increased.

(2) That the period of training must be greatly reduced so as to increase output of trainees.

(3) That the instruction given should be brief training in the use of simple machines and in carrying out simple operations.

The efforts of the technical colleges in the past, while excellent for peace-time training and development, have also been largely wasted for the same reasons. Here again rapid training of unskilled labour should be greatly extended. However delightful and useful in normal times the semi-scientific instruction given in technical colleges may be, there is no time for it under war conditions. Practical training on the simplest work is the only thing that counts.

But the main source of training is to be found not in the institutions referred to, but in the actual engineering workshops of the country. Here we have the machines, the material, the tools, and the actual jobs to do, and we also possess in our chargehands and skilled operators the most excellent practical instructors that can be desired.

Many engineering firms have faced this problem and have done fine work in training, but they are the exception rather than the rule. Although Trade Union opposition to dilution and the employment of women on jobs they have not previously done has been persistent, yet there are signs that, at all events in principle, this opposition is becoming less, though the time of the management is largely wasted by continual discussions of details. Most of these discussions appear to be brought forward not so much for the merit of the case in question but as a part of the general effort to retard the free use of diluted labour.

Many firms have apparently given up the fight, because of its difficulties, and the number of women even now employed, particularly in the machine tool industry, is almost criminally low.

Your pamphlet touches on the upgrading of labour, but not, I think, with sufficient emphasis. I believe all the members of your Institution will agree that one of the crying needs at the moment is for setters-up. Where are they to come from? There is only one source for supplying this type of labour, and that is from the ranks of the operators. Most operators are keen and anxious to move up in their trade, and the experience they have had in *working* machines makes them ideal for rapidly acquiring the ability to *set-up*.

The vacancies caused in the ranks of operators by promotion must be filled by the unskilled labour, male and female, which should be brought continually into the shops.

I have been doing my best for over a year to attract greater attention to these very vital problems, and while I am by no means proud of my own efforts (in fact I am gravely disappointed with them), still my own works has succeeded in employing 15% of women, who are freely working in all departments of the works. They are working with the men and they are doing splendidly.

The number of women employed in the engineering industry is only a fraction of the number employed during the last war. Why?

Yours faithfully,

ALFRED HERBERT.

THE INSTITUTION OF PRODUCTION ENGINEERS,
36, Portman Square, LONDON, W.1.
December 6, 1940.

DEAR SIR ALFRED.

The War Emergency Committee of the Institution have read with interest your letter of November 26, relative to the memorandum on the utilisation of labour under war conditions.

While the Committee are in full agreement with the sentiments expressed in your letter as to the necessity for quick training and absorption by industry of the available mass of unskilled labour, both male and female, they would point out that the memorandum, whilst touching upon all phases of the subject, was primarily intended to emphasise the important part which production engineers could play in achieving this objective by planning and tooling simplified operations which would enable labour to be trained through easy stages of production progression.

This memorandum is to be followed up by addresses to the various Sections of the Institution by Mr. B. C. Jenkins, late of Vauxhall Motors, Ltd., Luton, and now attached to the Ministry of Labour, in which the broader aspects, as raised in your letter, will be dealt with in an adequate manner.

Sincerely yours,

R. HAZLETON,
General Secretary to the Institution.

SIR ALFRED HERBERT, K.B.E.,
Dunley Manor, WHITCHURCH, Hants.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research).

ANNEALING, HARDENING.

Too Big for Flame Hardening ? by L. D. Jennings. (*The Machinist, November 25, 1939, Vol. 83, No. 42, p. 849, 4 figs.*).

Westinghouse engineers recently were confronted with the problem of surface hardening a number of 44,000 lb. lathe driving head spools which were forged from heavy ingots and were required to have a hardened surface of from 350 to 500 Brinnell, free from checks, cracks, and chatter marks, yet retain the maximum toughness of the core material. Flame-hardening and finish grinding operations were performed in a 120 in. lathe. Oxygen was delivered to the torches from a 20-bottle manifold, while an 18-bottle manifold furnished the acetylene. The hardened surface was turned, then ground to finished size with a soft fine-grained wheel on a motor-driven head mounted on the lathe carriage. As the work passes under the flame, it is quickly raised to an average temperature of from 1,500 to 1,550 F. by the double row of oxyacetylene flames $\frac{1}{8}$ in. apart at a temperature of approximately 6,300°F. As the material continues to rotate, it passes under the spray of water from the rear of the tip and is quickly quenched. The hardened surface is machined with a special tool and then ground to the finished diameter with a soft fine-grained wheel. The surface hardness of a finished spool is remarkably uniform.

BELTS AND ROPES.

The Application of Transmission Belting—X, by H. Stuart Jude. (*Power Transmission, 15 December, 1939, Vol. 8, No. 95, p. 613, 7 figs.*).

Belt pulleys. Crowned pulleys. Pulley faces. Fast and loose pulleys. Round rope pulleys. V-rope grooves. Long-centre V-ropes.

JIGS AND FIXTURES.

Fabricated Jigs for Welding Connections to Distribution Vessels. (*Electric Welding, November, 1939, Vol. IX, No. 49, p. 20, 8 figs.*).

The assembly jig shown was designed and fabricated to expedite the welding of mild steel tubular connections to mild steel distribution vessels and to ensure a high degree of positional accuracy.

MANUFACTURING.

The Manufacture of a Dry Shaver. (*Machinery, December 7, 1939, Vol. 55 No. 1417, p. 223, 15 figs.*).

Parts are produced in quantity to precision limits in the works of Rolls Razor, Ltd., Cricklewood. Constructional features of the dry shaver. The outer cutter for the Rolls dry shaver. Different stages of manufacture. Set-up on a Pedersen machine for the first milling operation. Fixture used for the third and fourth milling operations. Press tool used for forming the outer

cutter. Fixtures used for checking the alignment of the slots and the depth of the recess in the outer cutter. The combing and slotting operations. The machine used for lapping the working face of the outer cutter.

Press and Machining Operations in the Manufacture of Shell Cases. (*Machinery, December 14, 1939, Vol. 55, No. 1418, p. 265, 34 figs.*).

Sectional view of the shell case. Preliminary inspection of blanks. Weighing machine for blanks. Annealing and pickling plant. Initial drawing and indenting operations. Cutting-off and trimming. The heading operation. Tapering the neck. Machining operations on the case. Normalising and final pickling Operations on multi-spindle automatics.

The Final Assembly of Aircraft, by H. F. Schwedes. [*J.S.A.E.* (*U.S.A.*), *Vol. 45, No. 5, November, 1939, p. 15*].

An efficient line assembly calls for design on production lines. The various component assemblies are manufactured complete in jigs in various departments, and are brought in to final assembly completely finished and painted, no fitting or other hand work being required. It is essential, of course, that the sub-assemblies manufactured under this system are all ready for final assembly at the required time, and this necessitates efficient production control. Experience for this is gained by starting with a preliminary lot of say, five planes to complete tooling and checking of jigs. The final assembly is accompanied by moving the plane progressively through a set of stations (usually eight) with a special crew at each station trained for the particular work required. It is claimed that by adopting these methods, the North American Aviation Co. have established a peace-time production record over the first six months of 1939 by turning out 103 aircraft in one month of twenty-three working days.

Accelerated Aircraft Production for National Defence, by P. N. Jansen. [*J.S.A.E.* (*U.S.A.*), *Vol. 45, No. 5, November, 1939, p. 16*].

Prototypes must be turned out very much faster than in the past, and this means that many details of the structure will be more expensive, and fittings which eventually will be forgings have now to be hogged out of solid stock. This, however, does not mean that liaison between shop and design departments may be relaxed. In addition to being mainly " performance minded " the latter department must be " production minded " as well. As regards tooling, it is interesting to note that the author considers that any reduction in production costs is small once quantities in excess of 100 are handled. The major part of the costs are connected with installation of parts. accessories, and sub-assemblies. Extreme simplification of the major structural components (such as by the adoption of plastics) does not necessarily produce a reduction in production costs since the installation of accessories and sub assemblies is bound to become more difficult.

Dornier Stressed-skin Structures, by L. Petzold. (*Aircraft Engineering December, 1939, Vol. XI, No. 130, p. 451, 20 figs.*).

The experience of the Dornier-Werke G.m.b.H. in two important spheres of its work. (1) The development of a new method of mass production for fuselages; (2) results obtained with the stressed-skin main plane for the Do. 24. A typical fuselage mock-up mounted on its stand with the sliding pointer arm. Section of a mock-up showing two profiles and one distance piece. With the completion of the mock-up the preparation of detail cutting and drilling jigs is started. There are four types of jig in this category. (1) Drilling jigs for frame flanges ; (2) cutting and drilling jigs for the skin panel-

ling ; (3) cutting and drilling jigs for the longitudinal stringers ; (4) cutting and drilling jigs for the skin stiffeners and intercostal members. Arrangement of the belts round the profile plates which form the frame drilling jigs. Sub assembly units for the fuselage of the Do. 17. The " shallow trough " main structure before being put in the final assembly jig.

Machine Design and Motion Economy, by O. W. Habel and G. G. Kearful. (*Mechanical Engineering, December, 1939, Vol. 61, No. 12, p. 897, 9 figs.*).

The most important principles of motion economy are : (1) To eliminate unnecessary movements—(*a*) replace hand movement by mechanical movement ; (*b*) replace hand movements by foot or knee movement ; (*c*) eliminate the passing of work, tools, or controls from one hand to the other ; (*d*) combine movements by providing controls with multiple functions ; (*e*) provide for drop discharge of finished work. (2) To shorten and simplify necessary movements—(*a*) keep movements within normal work space ; (*b*) eliminate barriers ; (*c*) arrange for getting and disposing of material in adjacent locations. (3) To balance the work—(*a*) eliminate wait of one hand ; (*b*) keep both hands busy with useful work. (4) To minimise use of eyes—(*a*) eliminate hard-to-find controls (avoid small buttons) ; (*b*) aid positioning by use of bellmouths and bullet noses ; (*c*) keep necessary use of eyes within minimum area. (5) To eliminate use of hands for holding—(*a*) eliminate use of hands for holding machine part ; (*b*) eliminate use of hands for holding work. The illustrations demonstrate some ideas of good and bad motion economy design in machine tools.

Design Problems in the Quantity Production of Engines, by H. C. Hill. [*J.S.A.E. (U.S.A.), Vol. 45, No. 5, November, 1939, p. 16 and 21*].

The major difficulty in the quantity production of engines is the relatively large number of changes required (averaging in some cases 10 changes per 18 engines built). Such changes range from finning to connecting-rod design and are not excessive considering the extreme complexity of the modern power plant, such as a two bank radial. Accumulated service experience calls for design changes and it is the duty of the production department to see that such changes, whilst improving the article do not detract from the ease of manufacture. A case in point is the forged steel crankcase, machined all over, which now forms a characteristic feature of large power American engines. Such crankcases are as light as the previous alloy cases, but much more reliable. At the same time their cost is the same. A frequent source of hold-up in production is the multiplicity of inspections insisted on by customers. Careful specifications of requirements as to desired finishes and tolerances together with the application of useful surface finish instruments will avoid much of inspection controversy. Engine units must become more compact and more accessible. Provision must be made for an increasing number of accessories, each of which should be readily accessible and removable.

MATERIALS AND MATERIAL TESTING.

A Two-load Method of Determining the Average True Stress-strain Curve in Tension, by C. W. MacGregor. (*Journal of Applied Mechanics, December, 1939, Vol. 6, No. 4, p. A-156, 4 figs.*).

Description of a method, developed at the Massachusetts Institute of Technology, whereby the complete average true stress-strain curve in tension may be determined for a material from the beginning of yielding to fracture under ordinary testing speeds by the observation during the test of only two loads applied to a tapered specimen, namely, the maximum and fracture loads. Diameters at various positions along tapered specimens are measured before

and after the test, and stress and reduction-of-area values computed from these observations.

The Avoidance of Frost Bursting in Water Pipes, by J. McKoewn. (*Journal of the Institution of Heating and Ventilating Engineers, November, 1939, Vol. 7, No. 81, p. 399*).

Study of the effect of frost on water pipes, taking into consideration the properties of materials used for water pipes, the effect of low temperatures on these properties, the process of ice formation and its mechanical effects on pipes under widely varying conditions of service. Resistance of pipe materials to frost bursting. Movement of ice plugs. Methods of avoiding freezing. The only completely effective method of avoiding frost bursting is to prevent the formation of ice in water pipes, though damage resulting from freezing may be minimised.

MEASURING METHODS, APPARATUS.

Investigation of Dial Gauge Stand Arm, by Dr. G. Schlesinger. (*The Machinist, November 25, 1939, Vol. 83, No. 42, p. 526e, 11 figs.*). (Comp. *Engineering, December 29, 1939, Vol. 148, No. 3859* ; *Machinery, Lloyd, December 2, 1939, p. 13* ; *Mechanical World, November 24, 1939, p. 469, 18 figs.*)

Fixation points of gauge stand. Graphs of pressure and plunger stroke. Testing by rotating gauge. Testing deflection. Characeristics of dial gauges. The arms of test indicator stands are generally too weak. The deflection of the arm is caused by the weight of the dial gauge, which is about 6½ oz. plus or minus 1½ oz. to 6 oz. spring pressure. These forces bend the arm considerably and in particular are of decisive influence when the stand of the gauge is no longer stationary but is used by causing it to rotate on a horizontal axis. In such circumstances the plunger changes its vertical position from up to down when the dial gauge is swung round the axis to be checked. Swing-round tests. Deflection test. Details of new designed tubular arm. The proof is furnished that the ordinary one-sided arm of ½ in. diameter is wrong for the swing-round method. Therefore, the design of the one-sided arm has been changed to a concentric steel tube of 3½ in. diameter outside, 3 in. bore and 10 in. to 12 in. long, to which all holders are welded to avoid any joint. The deflections are now in all positions practically eliminated. A stress of 12 oz. equals weight of dial gauge plus greatest pressure of feeler spring cause at 12 in. length of arm only 0.00007 in. deflection which is negligible.

Rationalisation by Production-control and Inspection, by W. Kniehahn. (*Maschinenbau. Vol. 18, May, 1939, p. 219*).

The author emphasises the importance of system and measurement in the maintenance of general industrial efficiency. Citing as an example a commercial adding-machine, in which more than 70,000 manufacturing operations are required, he describes typical methods of improving or eliminating inspection. He illustrates a very accurate trigger, in which originally 39 tolerances required inspection, which was re-designed so that only 17 tolerances are needed. The relative cost of manufacture and inspection is illustrated by the gear-box casing of a milling machine and by a side-frame of the adding machine. In the former, making requires 335 minutes, and inspection twenty-five minutes, whilst in the latter, making needs five seconds and inspection twenty seconds. The percentages are therefore 7.5 and 400 respectively. In order to render inspection cheaper and more reliable, limit gauges are replaced by indicator methods ; and when the numbers are sufficient the parts are automatically inspected and sorted for selective assembly. The use of methods is recommended for quickly revealing faulty work—e.g., when a bush is pressed into a lever the assembly-pressure is used as a check on the fit of bush

and hole. By data from practice, the possibilities in instrument work of new ideas are demonstrated. The typical adding-machine labour is distributed as to one-quarter in making the parts and three-quarters in assembly, so that the savings realisable in assembly by making details perfect are more than sufficient to cover the extra manufacturing cost of those details. It is demonstrated how by proper planning and control the cost of such work decreases progressively from year to year.

SHOP MANAGEMENT.

Modified Quantity Production Methods for Small Components, by T. J.T. (*Machinery, December 14, 1939, Vol. 55, No. 1418, p. 287, 8 figs.*).

Plan of machine shop laid-out on the battery system. Typical small components in the machining of which milling, drilling, slotting and splining operations are involved. Plan of machine shop laid-out for the semi-mass-production system.

SMALL TOOLS.

Uses of Matrix Alloy in the Construction of Metal Stamping Tools, by C. L. Szalanczy. (*Sheet Metal Industries, December, 1939, Vol. 13, No. 152, p. 1,443, 10 figs.*).

Punch-press tools are now built in such a manner as to reduce the construction time to the minimum. Instead of using tool steel hardened and ground, the frames were roughly burned out on the inside to a dimension somewhat larger than the assembled die pieces, and a molten alloy was poured into the opening between the die parts and the frame. A new alloy to be known as "Cerromatrix," was introduced to the metal-stamping and tool-making industry. The new alloy is made of a composition of lead, tin, bismuth and antimony. On various tests the tensile strength of the matrix metal has been found to be about 6 tons per sq. in. with a Brinell hardness of 19. During these tests the elongation was about 1% in 2 in. During cooling an expansion of approximately 0.002 in. per in. takes place. A large die of the sectional type is shown, held in the frame with matrix metal. Tests showed also that under normal conditions the matrix alloy will resist 7.2 tons per sq. in. for thirty seconds without deformation. The melting point of the matrix alloy is very low—120°C.—a feature that was also found to be an advantage. Because of this low melting point, the heat of the molten alloy does not have any effect on the hardness of the tool-steel die parts in contact with it. The pouring temperature is from 149°C. to 177°C., and the freezing or hardening range of the alloy is from 127°C. to 102°C. Another uncommon feature of this alloy is that it hardens with age. For this reason it is advisable to allow the tool to set for twelve to fifteen hours before placing the tool in production. The toolmaker should have no difficulty in applying or pouring the molten matrix alloy into the die assembly. The illustrations show : The method of pouring molten matrix around a segment die. Arrangement of punch parts before they are fastened together. Punch parts assembled, properly spaced and fastened. Punch assembly in the finished state. Stripper made by pouring matrix alloy around the punches.

STANDARDISATION.

Standard Notations : A Résumé of the British Standards Specification No. ***499*** **" Nomenclature, Definitions and Symbols for Welding and Cutting,"** ***1939,*** by Conrad W. Hamann. (*The Welder, October-November, 1939, Vol. XI No. 71, p. 290, 90 figs.*).

Section I is devoted to the defining of general matters, which come under the main heads of : (*a*) Common terms ; (*b*) Types of welded joints ; (*c*)

Test pieces; (*d*) Cutting terms. Section II treats solely of the definitions of forge welding, in two subsections, namely: (*a*) Forge welding methods; and (*b*) Types of forge welded joints. Section III (definitions for pressure welding), is sub-divided into three parts: (*a*) Pressure welding methods; (*b*) The terms " contact area " and " flash or fin "; (*c*) Types of pressure welds. Section IV (fusion welding) is divided into the following eight subsections: (*a*) Fusion welding methods; Gas blowpipe welding; Electric arc welding; Metal arc welding; Carbon arc welding; Shielded arc welding; Atomic hydrogen welding; Thermit fusion welding; (*b*) (*c*), and (*d*). These subsections define various terms used in the gas, arc and thermit welding processes. (*e*) Fusion weld terms; (*f*) Fusion welds; (*g*) Fusion welds for joints; (*h*) Fusion welded joints. Section V (equipment and supplies). This section, which is the last in the standard, is divided into five subsections, namely: (*a*) General; (*b*) Resistance welding equipment; (*c*) Electric arc welding equipment; (*d*) Gas welding and gas cutting equipment; and (*e*) Thermit welding equipment and supplied. Symbols are given for indicating the standard plate preparations for butt welds.

SURFACE TREATMENT.

Surface Pre-treatments Enhance Finish Durability, by E. E. Halls. (*Part I, The Machinist, December 2, 1939, Vol. 83, No. 43, p. 540E, Part II, December 9, 1939, Vol. 83, No. 44, p. 554E*).

I. In the electrical industries, production invariably involves the use of organic coatings of paint, enamel and lacquer both for protection and decoration. The finish must be durable through the service life of the equipment—in some cases ten to twenty years. Chemical pretreatments prior to painting or enamelling fall into this category. (*a*) Pre-cleaning. Remove all oil and grease and extraneous dirt, solid dirt, swarf, rust. Scale must be removed, shot blasting being advocated for this purpose. Immersion phosphate treatments are effective on top of scale. (*b*) Phosphate treatment proper. (*c*) Water washing. (*d*) Chromating. (*e*) Drying off. The general purpose phosphate treatments are immersion processes. Trichlorethylene cleaning is preferable if no rust or scale is to be removed or if shot blasting is going to be adopted for the latter. The spray line comprises the alkali zone followed by two water rinses, the phosphate followed by a water rinse and a chromate, all of these being continuously fed by pumps and finally an oven for drying off on the end of the chain. Spray plants are less frequently employed. The object of phosphatising is to provide, in conjunction with the enamel coatings subsequently applied, a rust-proof finish. Although phosphatising on its own is useless as a protection, yet in conjunction with a single coat of paint or enamel the durability of the finished work is superior to many two-coat finishes applied directly or applied to cleaned shot-blasted surfaces.

II. A large number of articles treated by each type of process and finished in various manners have been examined and submitted to artificial ageing and to durability tests, and the average results are summarised in Tables. (1) Durability of enamelled sheet metal work. No chemical pretreatment. (2) Ditto, having special primers. (3) Ditto, work having chemical pretreatment. (4) Durability of enamelled structural steel work. No chemical pretreatment. (5) Ditto, steel work having chemical pre-treatment. (6) Properties of media employed for finishing specimens. Electrical engineering is an admirable field in which to exploit the advantage of phosphatising. Finish coatings on surfaces pretreated by this means exhibit maximum adhesion, and durability with minimised ageing and embrittlement effects.

Electrodeposition of Nickel. (*The Nickel Bulletin, November, 1939, Vol. 12, No. 11, p. 210*).

Nickel plating of zinc-base die castings. Nickel deposits. Copper-nickel deposits. Nickel-copper-nickel deposits. Barrel finishing and nickel plating on zinc. Influence of temperature on electrodeposited nickel coatings. Passivity characteristics and the nickel plating of stainless steel.

Automatic Painting Machine for Long Bars and Sections. (*Engineering, December 29, 1939, Vol. 148, No. 3859, p. 717, 8 figs.*).

The application of protective coatings to articles the length of which is great in relation to their width and depth presents a number of problems when large quantities have to be dealt with. The machine is being used for the application of lead and other paints to wooden glazing bars, ridge rolls, hip rolls, cappings, sills and other sections, such as are used in building construction, and also to tongued and grooved boards of various sizes. Upwards of a dozen cross-sectional forms are dealt with at the rate of 60 linear ft. per minute, all surfaces being painted at one pass. The machine consists of a central painting unit through which the sections are passed by a pair of double-strand chain-and-slat conveyors. The conveyors are coupled together, and are driven by a reversible geared motor unit. The painting unit shown is in the form of a rectangular chamber open at each side. Adjacent to each opening, on a semi-circular mounting above the conveyor level, is a battery of four automatic spray guns. Actuation of the spray guns is by compressed air, electrically controlled. The efficiency of the fume-exhaust system, coupled with the fact that each operator stands at least 12 ft. from the painting unit, prevents injury to health.

WELDING, BRASING.

Welding Technique in Aircraft Construction, by Kurt Queitsch. (*Aircraft Engineering, December, 1939, Vol. XI, No. 130, p. 455, 23 figs.*).

Some practical hints on the welding of steel tubes. Strains caused by heating. The theory of "contra-heating." The manipulation of blowpipe and welding rod for welds in steel tube. Welding rod technique. How to use wire and blowpipe when welding a badly fitted strut. The butt welding of steel tubes. The different welding sequences which were tested. Welded T-joints at tubular struts—operations and sequence. The welding of oblique tubular joints. Welding of cross joints of steel tubes. Angle joints of steel tubes. Braced steel-tube angle joints. Welding of gusset plates (web reinforcements) to tubular joints. Arrangement and sequence of seams for the prevention of overlapping.

New Thoughts About Contact Resistance in Spot Welding, by Frank J. Studer. (*Sheet Metal Industries, December, 1939, Vol. 13, No. 152, page 1,475, 9 figs.*).

The nature of contact resistance. Experimental arrangements. Types of samples used. Typical pressure-resistance curve, 18-8 stainless steel, polished finished. Effect on contact resistance of area of overlap and size of electrode tips. Contact resistance and surface conditions. Contact resistance as a function of pressure. Typical log-log plots, pressure-contact resistance. Dependence of contact resistance upon temperature.

Some Factors Affecting the Efficiency of Welded Joints, by W. Chamberlain. (*The Welder, October-November, 1939, Vol. XI, No. 71, p. 311, 4 figs.*).

Common faults associated with welding can be classed under the following headings : (1) Undercutting. (2) Lack of root penetration. Undercutting

can be caused by any one of several factors or a combination of all. These factors are as follows : (*a*) Too long an arc length ; (*b*) too high a current value for a given size of electrode ; (*c*) using the wrong type of electrode for this class of work ; (*d*) trying to deposit too large a fillet in one run ; (*e*) using incorrect angle of the electrode. The causes of lack of root penetration may be classed under the following headings : (1) Size of electrode ; (2) current value ; (3) preparation of joints.

A Critical Examination of Methods of Testing Welds, by J. M. Willey. (*The Welding Industry, December, 1939, Vol. VII, No. 11, p. 393, 13 figs.*).

Concluded from "The Welding Industry," November, 1939. There are numerous types of impact test specimens, although Izod is the normal in this country. The values vary distinctly, depending on the particular test employed. Shape and size of the most common impact test pieces. Izod (standard), Charpy, Mesnager, Swiss, German, Izod (round). Fatigue test. Goodman's endurance limit diagram for mild steel. Wöhler's diagram for mild steel, in rotating flexure. Type of test piece for endurance by rotating flexure, proposed by the Dutch regulation V551. Forgeability tests. Incorrect type. of test piece used for a test of forgeability. Ideal test piece for a test of forgeability. Economical test piece for a test of forgeability. Method of making another type of piece for testing hot forging qualities.

Welding with Stainless, by V. W. Whitmer. (*The Machinist, November 25 1939, Vol. 83, No. 42, p. 857*).

The stainless and heat-resisting steels all contain basically a high chromium content ; that is, in excess of 10% chromium with or without nickel, molybdenum ; silicon and other alloys. For convenience in welding, they should be divided into two general classes—those containing chromium with less than 5% nickel (straight chromium types) and those with chromium and 7% or more nickel (chromium-nickel types). All of the stainless alloys can be gas or electric arc welded with either the metallic or carbon electrode. Resistance processes such as spot, seam, butt and flash, work very well, as do atomic hydrogen and the "Unionmelt" process. Forge welding, however, is unsatisfactory because of formation of a refractory scale on the surfaces during heating. Welding conditions are : correct fitting of the joints ; maintenance of heat as low as possible ; butt welds are preferable ; with heavy sections $^{3}/_{16}$ in. and over welding should be from both sides, scarfing at 60° or 90° ; welding rod or filler metal or the same analysis as that of plate being welded ; penetration should be complete. Metallic arc welding, using flux coated electrodes, is used most extensively in general tank work for the chemical, process, food, dairy and other industries where a high polish often is necessary for maximum sanitation or corrosion resistance. Atomic hydrogen is probably the most satisfactory method of welding where smooth surfaces are required and where grinding or other finishing is impossible.

Oxy-Acetylene Welding on Copper Pipe Installations, by E. Christie. (*The Heating and Ventilating Engineer, December, 1939, Vol. XIII, No. 150, p. 248, 11 figs.*).

The flame for fusion welding copper should be one or two sizes larger than that employed for steel of similar thickness, and should be strictly neutral. The flame should also be soft—i.e., slightly lower pressures on both regulators than is generally used for ferrous metals. A cleaning flux is necessary to facilitate the welding operation and this is supplied in powder form. Copper in the molten state has an affinity for oxygen and to reduce the adverse effects which would be created by allowing the atmosphere to attack the metal when in a

state of fusion, it is essential that the joint should be welded as quickly as efficiency will allow and without taking the flame away from the work from start to finish. Six figures illustrate correct preparation. Light gauge tube tee joint flanged for copper fusion welding. Butt joint tacked in position for fusion welding. Completed fusion butt joint. Bronze welding can be successfully carried out on either deoxidised copper or tough pitch copper. Plain tee joint. Plain butt joint, completed by built-up copper fusion welding. Plain butt tee joint. Section of weldable fitting showing light gauge copper pipes fitted hard against annular stop ring, and recess for bronze filler metal. Cup tee joint. Diminishing joint.

New Processes for Welding and Soldering Zinc, Aluminium, and Magnesium, by K. Heinemann. (*Z.Metallk, Vol. 31, May, 1939, p. 141*); (*Eng. Absts., Vol. 2, No. 8, Section 2, August, 1939, p. 112*).

In order to avoid the use of lead-tin alloy ordinarily required for soldering pure zinc, a welding process has been developed. For galvanized sheet a zinc flux and zinc wire are used, the temperature of about 420°C. (790°F.) being obtained with a flame. Most zinc alloys cannot be satisfactorily welded, especially if they contain aluminium. For these alloys a kind of puddling weld can be made by using a templet, melting wire over the joint, and puddling the oxide out of the weld. Aluminium and its alloys can be welded, using covered electrodes, with a current of 140-280 amp. at 25-30 volts. This method is especially suitable for 5-10 mm. (0.2-0.4-in.) sheet; for thinner sheets, the Weibel method is recommended. In joining aluminium cables, the ends are passed into a graphited steel mould and a stearin flux is added; the whole is heated to 850°-900°C. (1,560°-1,650°F.) and aluminium is poured in, the insulation being protected by screening and cooling. Another method involves the reaction of heavy-metal chlorides with a soft aluminium solder, but there is a danger that the oxide skin may not be completely dissolved. Commercial magnesium alloys are, in general, easily weldable; those containing aluminium can have only short welds, owing to their liability to weld-cracks. Magnesium is also now used in conductors of interior switches; for welding these, the ordinary flux and pure magnesium wire are used with a supporting templet. In repair welding of magnesium castings, the weld requires protection owing to the impossibility of removing the last traces of flux, which may lead to corrosion at the weld-seam.

Research Department : Production Engineering Abstracts

(Edited by the Director of Research).

ANNEALING, HARDENING, TEMPERING.

Flame-hardening. (*The Machinist, January 6, 1940, Vol. 83, No. 48, p. 965, 1 fig.*).

Flame-hardening is a process whereby the surface of a quench-hardening ferrous material is locally heated by means of an oxy acetylene flame followed by a suitable quench, usually a stream of water. Flame hardening has an advantage in that no change of chemical composition takes place in the hardened surface. Only the portions of the surface which require hardening need to be so affected. Speed of operation. Case characteristics. Sections treated. Quenching. The operations of flame hardening may be classified as : (1) Stationary ; (2) progressive ; and (3) spinning. In the stationary procedure, the blowpipe and the work are both motionless during the operation. In the progressive method, the flame and work are moved relatively to each other, and the metal is quenched as it is brought up to temperature by the moving blowpipe. In the spinning method, applied principally to rounds, the blowpipe is stationary and the work is rotated before the flame. Certain steels cannot be quenched with water, in which case soap-water solutions or soluble cutting oil in water can be used. Flame-hardening is used for treating rail ends, pump liners, crane wheels, gears, tractor shoes, sheave wheels, machine ways, valves, crankshafts, camshafts, and similar parts. Oil-field applications include ball-races for rotary tables, universal joints for mud holes, draw works, gear teeth, sucker rods, and box and pin ends of drill pipe. Plain carbon steels can be hardened satisfactorily provided the carbon is more than 0.40%. The upper limit of carbon is generally safe up to 0.70% carbon. The application of the method for alloy steels is restricted generally to the low or medium alloy types.

Hard-surfacing Steel and Cast Iron. (*The Machinist, January 20, 1940, Vol. 83, No. 50, p. 1007*).

Hard-surfacing or hard-facing is the welding to wearing parts of a facing, edge, or point of hard special alloy possessing unusual wearing resistant qualities. It protects surfaces which normally wear rapidly in service. Four types of hard-surfacing alloys for steels have been developed. These are : (1) Low-alloy steels ; (2) high-alloy steels ; (3) non-ferrous alloys ; and (4) diamond substitutes. The order of preference for various uses of these alloys are given in tables with the headings : Material, alloys used, characteristics, technique.

Surface and Hardening, and Hard Surfaces, by C. P. Keogh. (*The Australasian Engineer, November 7, 1940, Vol. 39, No. 282, p. 71*).

The general term " wear " may imply any one or more of the following phenomena : " Abrasion, erosion, galling, corrosion." Their definitions. The engineers problem is to provide materials for metal parts capable of withstanding for a reasonable length of time the conditions which they will encounter. It is not always possible to decide upon the best combination of hard-

ness, toughness and corrosion-resistance for any particular application, because it is always difficult to interpret ordinary physical properties in terms of wear-resistance. *Hard surface and hardening processes* : Case hardening ; nitriding ; flame hardening ; work hardening ; metal spraying ; electro plating ; sintering ; rolling and forge welding ; furnace brazing ; carbon arc torch ; atomic hydrogen torch ; oxy acetylene ; oxy hydrogen ; oxy coal gas ; carbon arc welding ; metallic arc welding ; electric resistance welding. Explanation of processes. Types of steels which can be satisfactorily flame hardened and the treatment recommended. Air-hardening steels. Oil hardening steels. Water hardening. Australian (B.H.P.) steels treated. Medium and high carbon steels. Cast iron. Alloy steels. It is necessary that further attention be directed to : (1) The provision and use of more weldable base material, allowing increased scope for these special applications of welding ; and (2) the intelligent application of heat treatment to the alloys used, to ensure the best results from hard-surfaced or surface-hardened work.

The Influence of Controlled Furnace Atmosphere in the Heat Treatment of Steel, by A. Fisher. (*Machinery, January 4, 1940, Vol. 55, No. 1421, p. 355, 5 figs.*).

The majority of the heat treatments are carried out with the main object of producing a structure in the steel which is responsible for, or at least is associated with, the physical properties it is desired to obtain, and the question of surface deterioration has usually taken a second place. The atmosphere surrounding the steel being treated will, if uncontrolled, vary with the type of fuel used for heating the furnace, with the combustion conditions (air to gas ratio, etc.), with the type of furnace, and with several other factors. There are four groups : (*a*) Reducing and carburizing ; (*b*) reducing and decarburizing ; (*c*) oxidizing and carburizing ; (*d*) oxidizing and decarburizing. The object of using controlled atmospheres is to prevent the harmful oxidizing and decarburizing reactions from taking place. The particular atmospheres used in controlled heat treatment may be tabulated as follows : (1) Charcoal gas ($CO + CO_2 +$) ; (2) cracked ammonia ($N_2 + H_4$) ; (3) atmosphere obtained by controlling combustion ; (4) mixed burnt and raw gas ; (5) raw gas (town, producer, or natural gas) ; (6) simple hydrocarbon gases (propane, butane, etc.) ; (7) atmospheres generated from cast-iron borings, spent caruburizer, etc. ; (8) any of the above doped with CH_2 (methane) or purified by removing CO_2 and/or H_2O vapour. Furnace atmosphere relations. Charcoal gas reactions. Charcoal-gas equilibrium with steel. Hydrogen and H_2O vapour in charcoal gas.

Heat-treatment Department, by J. Bentley. (*Electrical Engineer, December 15, 1939, p. 190*). (*Met. Vickers Tech. News Bulletin, No. 690, December 22, 1939, 7 figs.*).

This article deals with the electrical installation and equipment of a heat-treatment department. The author discusses the size and rating of furnaces, and in connection with choice of resistance material, the use of nickel chrome alloy is advocated. Supply transformers, temperature control devices, contactor and busbar arrangements are discussed and notes on the control of maximum demand are given. The position of control instruments and thermo couple leads is discussed.

ACCOUNTING, ADMINISTRATION.

Process Costs, by W. Crosskey. (*The Cost Accountant, December, 1939 Vol. 19, No. 7, p. 152*).

Process costing is the method whereby we define an " operation " and throw into relief the component costs of that operation, including overheads, by

dividing them by the common unit being treated. It is very important to define where the process begins and ends. It is advised to make the process collect from the previous one, as a logical follow-up from the first operation having to pay to have its goods delivered from suppliers. *Building up process costs.* A simple form of what one could call the department or process order number book. During the period of costing, the details of the batches going through a certain operation and the summary would appear as shown in another form. Process cost sheet. Build up the cost of the individual products. Applications. The process cost sheet could be extended to include a column for standard costs per unit, and the increases or decreases can be investigated before issuing, so that the process superintendent has the full story. Definition of terms. The author suggests that a private costing dictionary be prepared for use in the works and such items as " indirect labour," " supervision," etc., be clearly defined.

BELTS AND ROPES.

The Application of Transmission Belting—XI, by H. Stuart Jude. (*Power Transmission, January, 1940, Vol. 8, No. 96, p. 659, 5 figs.*).

Pulleys must be in perfect alignment, or the belt cannot run true. Belts and pulleys must be kept clean, or proper contact is impossible. Driving the belt in the proper direction is important. The golden rule prescribes that the tip of the splice on the outside of the belt should follow through. Care is necessary when deciding upon accurate length to cut a new belt. Measure or calculate the exact length round the pulleys, and then deduct the allowance for initial tension. This varies according to the type of material : Oak-tanned leather (ordinary), 2% ; oak-tanned leather (wet stretched), 1% ; rubber, 1% ; balata, 1% ; hair, 1.5%. Cutting to length must be done with a steel square. Fasteners and leather laces need to be fitted carefully. Belt stretchers should always be used. " Roping on " is a practice which should never be resorted to. Excessive tension is destructive to the belt texture. Insufficient tension, on the other hand, results in either slip or the necessity for repeated tightening, or, more generally, both. Belts should never be too thick to conform comfortably to the diameter of the smaller pulley. Belts hanging idly from revolving shafts are dangerous. Suitable surroundings, both in operation and in storage, are important. Over-dressing is worse than underdressing. Fork action need not be destructive. The scrubbing action can be materially reduced by fitting rollers to the striking gear. The usual " remedy " for slip—employing a stronger belt—often aggravates the trouble. Belts can only be depended upon to deliver their full power when they are in operation on a " perfect " drive. Every belt gains or loses power ability on each of the following counts : (1) Type of load—steady, intermittent or shock (2) arc of contact ; (3) the layout of the drive ; (4) small pulley diameter ; (5) effect of contrifugal force. Figures and formulae. Open belts. Crossed belt. Belt length in the roll. Belt speed. Horse power formulae.

JIGS AND FIXTURES.

Chuck for Gripping Threaded Components. (*Machinery, January 18, 1940, Vol. 55, No. 1423, p. 415, 2 figs.*).

Sectional views of collet-type chucks for gripping threaded components, such as shells and fuses. The feature of the design being that it provides for the accurate centring of the component from the flanks of the thread, and its positive location from a face machined at a previous operation. Section of chuck for gripping components threaded internally. Section of chuck for gripping components threaded externally.

Floating Tool Device, by F. Horner. (*The Machinist, December 16, 1939, Vol. 83, No. 45, p. 566E, 2 figs.*).

A floating motion to a tool or its holder should allow the tool to follow freely the general alignment of the machined surface. Yet sufficient restraint must be provided to prevent the starting end of the tool from straying and making a bell-mouth, with likelihood of damage to the end as well. Illustrations: (1) Restricting play of floating shank; (2) extension for anti-sag screws and spring-supported plungers; (3) supplying coolant through floating shank; (4) quick-change holder with clutch connection; (5) ball-floating action; (6) another ball-floating action; (7) floating cutters in rigid bars; (8) quick-change drill chuck; (9) adjustable holder for aligning tool.

MACHINE ELEMENTS.

A Simple Electro-magnetically Controlled Speed-change Mechanism. (*Machinery, December 21, 1939, Vol. 55, No. 1419, p. 311, 6 figs.*).

Use is made of electric current of comparatively low voltage, for locking and unlocking epicyclic gear trains incorporated in the mechanism. The Cotal transmission has units which are very compact. For a 350-h.p. Diesel engine which at 1,200 r.p.m. transmits a torque of 1,500 ft.-lb., the diameter is 22 in., and the overall length less than 10 in. Electro magnets are used for bringing the different epicyclic gear trains into operation and for locking them solid to give a direct drive. Sectional view of the unit. Application to machine tools. Motor drive conversion units.

Twin-disc Clutch for Industrial Applications. (*Engineering, January 5, 1940, Vol. 149, No. 3860, p. 8, 2 figs.*).

The leading feature of the twin-disc clutch is that the friction area is exceptionally large to ensure long life and to reduce adjustment to a minimum. There is no thrust on the crankshaft of the engine to which it is applied, the adjustment is simple, and the disc or discs are driven at the point of least load. The power-take-off model as twin-disc clutch for stationary engines is illustrated.

MACHINE TOOLS.

A New Method of Machine-tool-spindle Analysis, by Thomas Barish. (*Mechanical Engineering, November, 1939, Vol. 61, No. 11, p. 813, 9 figs.*)

A well-known type of surface grinder is regularly manufactured with the motor mounted directly on the spindle. The two major deflections were in the spindle and in the bearings, the wheel holder and housing being large enough to make their yielding negligible. After the machines were built, the deflections at the load point were measured. They checked quite satisfactorily to within about 5% of the calculated values. General method of comparison. Two-bearing spindle. Three-bearing mountings. Deflections of bearings and shaft of two-bearing heavy-duty shaft for a multiple-spindle automatic. Deflections in redesigned spindle, utilizing two bearings in parallel at either end. The maximum calculated yield at the work of 0.00093 in. seemed somewhat high compared to the measured figure of 0.00074 previously given, but the difference is probably entirely due to the small stiffening effect of the clamping and sleeves on the spindle. Test arrangement for comparing rigidity of parts of oscillating-race grinder. Spindle deflection versus centre-bearing space of redesigned work head. Spread of bearings. Two-bearing mounting. Final design and deflection calculations.

Multi-tool Lathe Practice. (*Machinery, January 18, 1940, Vol. 55, No. 1423, p. 409, 15 figs.*).

For work whether of simple or intricate form, automatic lathes are commonly used, with advantage, for the production of batches which necessitate fairly long runs. In many shops, however, a considerable quantity of lathe work is involved which does not justify the installation of expensive automatic machines, and much of this can conveniently be handled on multi-tool or multi-cut lathes. The 6 W.S.L. Small piece multi-tool lathe, with motor-driven headstock. Tool layout showing typical applications of the front and rear slides. Set-up for taper boring and facing a gunmetal cock body. Tool layout for machining the cook body. Tool layout for turning and facing a 3.45 in. shell. Tool layout for turning, grooving, and forming a motor-car piston. Tool layout for turning and finning an aero-engine cylinder barrel. Tool-layout for machining a nickel-chrome steel bevel gear.

Lapping for Final Finish, by H. J. Wills. (*The Machinist, January 13, 1940, Vol. 83, No. 49, p. 985, 1 fig.*).

Lapping is a final operation which has four chief purposes : (1) To secure great accuracy of dimension ; (2) to correct minor imperfections of shape ; (3) to provide a fine surface ; (4) to provide a fit between two surfaces. Lapping is also a material removing operation, but not an economical one when large amounts must be removed. A surface to be lapped should, therefore, be first carefully ground, usually to within 0.0005 in. at the most, although in few cases, where a comparatively large amount of inaccuracy must be corrected, as much as 0.001 in. may be removed. Polishing and buffing are used solely to get a desired appearance, or optical effect. They are not used for correcting dimension or shape. Hardened steel gears are lapped to remove cutter marks, to correct imperfections in profile and spacing and to remedy distortion caused by heat-treating. Lapping has many uses in the tool-room : for finishing gauges, dies and moulds, and for sharpening Stellite and tungsten carbide cutting tools. Lapped tungsten-carbide tools give on the average as much as 100% greater production per grind, when used for fine finishing cuts or on materials that have a high abrasive action. In the more effective modern practice the abrasive is embodied in a suitable carrying vehicle and allowed to roll between the lap and the work. The harder the lap the slower the cut, the greater the accuracy, the duller the finish and the more rapid the wear on the lap. Abrasive for a lapping range from 60 down to 1,000 grit. The latter is a very fine powder which is used for fine, soft lapping. The abrasives are usually held in vehicles (so called " lubricants ") which range from alcohol or water through various oils to heavy bodied greases. The speed and the quality of a lapping operation depend on several variables, such as : material to be lapped ; material of the lap ; and the personal skill and even psychology of the operator. Pressure of laps against the work also effects both speed and finish. Finally lapping recommendations are given, containing : uses, compounds, abrasive, approximate grit, vehicle, solvent.

A Wide-range Universal Dividing Head. (*Aircraft Engineering, January, 1940, Vol. 12, No. 131, p. 27, 3 figs.*).

The section through the driving elements of a Cincinnati universal dividing head and the complementary elevation serve as a general indication of the construction of the dividing head. A point of particular interest is the way in which the tapered work spindle has been supported almost throughout its length. A further precaution against straining the spindle is incorporated for use in cases where very heavy cutting operations have to be performed. This consists of a clamping attachment which provides a means of holding the spindle very firmly in its front bearings. Three different views of the Cincin-

nati universal dividing head fitted with the wide-range divider. The wide-range head is extremely useful for precision work as it permits the rapid selection of specific angles to the nearest second and is capable of dividing a circle into parts as small as 1/400,000.

Simple Methods for Junction Pieces, by W. Cookson. (*Sheet Metal Industries, January, 1940, Vol. 14, No. 153, p. 65, 8 figs.*).

Perhaps the most interesting of the many problems met with in air duct and dust extraction work are those which are concerned with the development of patterns for breeches and multiple-way junction pieces. A perspective view of one branch of this type of breeches, placed on a horizontal plane. On the vertical plane is depicted an elevation as projected from the outline of the object. The method of developing the pattern for the branch is shown. Multiple junction pieces. Pattern for three-way junction pieces.

MANUFACTURING.

Surface Broaching, by W. Whitworth Taylor. (*Practical Engineering, January 27, 1940, Vol. 1, No. 1, p. 11, 3 figs.*).

The principal advantages of surface broaching are: (1) High production; (2) low cost per piece (where volume of production makes initial cost economically feasible; (3) one operation roughs and finishes; (4) good finish; (5) close tolerances; (6) infrequent tool-sharpening; (7) skilled labour not required. The limiting factors in the successful application of surface broaching are: (1) Work must be strong enough to stand broaching stresses set up; (2) it must be possible to apply fixtures which will support the work firmly; (3) work must not have any obstruction in plane of surface to be broached; (4) material to be surfaced must be within the range of machine-ability with edged tools; (5) depth of stock must be held within close limits. Comparative feed rates. How the broaching tool works. Types of surface broaches.

Rifle Parts—Broached. (*The Machinist, December 16, 1939, Vol. 83, No. 45, p. 902, 15 figs.*).

Case studies of rifle manufacture prove the value of broaching in high-speed production of trigger guards and sight bases.

Broaching Hits the Mark. (*The Machinist, January 13, 1940, Vol. 83, No. 49, p. 994, 6 figs.*).

Past methods of multiple operations on rifle parts have yielded to the simpler speedier process of broaching. One ordnance factory has installed a battery of 26 standard vertical broaching machines for this purpose. Examples: Trigger guard, rifle bolt, rifle trigger, front locking lug.

Electroforming, by Samuel Wein. (*The Machinist, January 13, 1940, Vol. 83, No. 49, p. 606E, 4 figs.*).

Electroforming is the term used by electro-chemists to designate the art or science of forming metallic products by electrochemically depositing metal on a mould, and then after the desired thickness of metal has been attained, of removing the mould from the metallic product. Examples of the work are shown in the illustrations. Hollow ball and branch tubes electroformed. Filter screens. Copper mould for paper boxes. Electroformed die and force and decorative inlay. Selected list of fusible metals ranged by: flow, composition per cent.

MATERIALS, MATERIAL TESTING.

Nickel in Cast Iron. (*The Nickel Bulletin, December, 1939, Vol. 12, No. 12, p. 240*).

In connection with the interest in flame-hardening of lathe beds and other parts requiring high wear-resistance, it has been shown that the use of balanced amounts of nickel, chromium and molybdenum have a valuable influence in enhancing the response of cast iron to flame-hardening. A very comprehensive study has now been made of the types of iron best suited for flame-hardening, and of the conditions requisite for production of the optimum combination of hardness, toughness and freedom from distortion. Three series of cast irons were investigated, both as plain irons and with alloy additions. The surface hardnesses obtained by the various treatments are shown, and the depth of hardening effected in different types of iron is illustrated. The curves show that nickel and nickel-chromium additions increase penetration, and that the lower the carbon or silicon content, the greater is the depth of hardening. A table indicates that distortion increases with increase in the depth of the hardened layer, but that distortion per 0.1 in. of penetration is considerably less in alloyed than in plain irons.

Nickel Steels and Alloys in Machine Tools. (*The Nickel Bulletin, December, 1939, Vol. 12, No. 12, p. 249*).

On the table are shown the representative applications of nickel alloy steels in machine tool construction. Approximate chemical composition, per cent. of direct hardening steels and case hardening steels. Nickel increases the strength properties of most of the common bronzes, both in tension and compression, being particularly effective in raising the elastic properties. Nickel effectively promotes fluidity, giving a wider casting range, and also has a densifying influence, resulting in increased pressure tightness.

Stainless Steel for Aircraft Structures, by H. W. Perry. (*Aircraft Production, February, 1940, Vol. 2, No. 2, p. 35, 9 figs.*).

Properties of stainless steel. Example of stainless-steel fabrication : an elevator frame for a Seversky pursuit aircraft. Stages in the formation of corrugated sheet. A diagrammatic view of the method employed to hold the stainless-steel skin and the corrugated sheet in position during the welding process. Standard corrugations in light metal sheet (top) compared with those of stainless steel. Typical sections used for stringers or stiffeners with stainless-steel stressed skin construction. A striking example of the possibilities of stainless-steel construction : the wing structure of a Fleetways amphibian aircraft.

Bearing Metals and Bearing Design, by R. S. Russell. (*The Australian Engineer, December 7, 1940, Vol. 39, No.. 238, p. 16, 6 figs.*).

The article is written mainly from the point of view of the metallurgist, but the importance of some of the factors affecting design and lubrication are discussed. The position of shafts in bushes at various speeds. There is need for bearing metals for the following reasons : (1) Metallic contact occurs on starting up ; (2) deformation may occur under load ; (3) mating surfaces are never absolutely smooth (especially when new) or truly concentric ; (4) shafts and bearings are never truly cylindrical or perfectly aligned ; (5) the lubricating qualities of the oil may deteriorate by accumulation of impurities and by oxidation. Constitution of the tin-base alloys. Constitution of the lead-base alloys. Typical details of tin base and lead base bearing metals : tensile test, composition, brinell hardness, compression tests. The effect of antimony on

tin-base bearing metal containing 3½ copper. The effect of 1% cadmium on tin-base bearing metals. Cadmium-nickel bearing metal. Running up. Bearing corrosion. Fatigue.

Synthetic Materials as Bearings for Mills. (*British Plastics and Moulded Products Trader, January, 1940, Vol. 2, No. 128, p. 359, 6 figs.*).

Laminated products are the materials used in making bearings. Laminated materials are made by impregnating rolls of paper, fabric or asbestos sheet or cloth with a solution of resin in spirit. The dried impregnated material is then cut into sheets of certain size, which are stacked together and presses between metal plates in large hydraulic presses of the order of one to two tons per sq. in. and a temperature of 150°C. The laminated material can be very easily machined. Its specific gravity is 1.35. It fills the gap between wood and the light metal alloys. The tensile strength across the face in two directions is between four to five tons per sq. in. Its shear stress through the laminations is between four to five tons per sq. in., while its compressive stress flatwise is somewhere near 18 tons on a 1 in. cube. The Brinell hardness, using a load of 125 kg. on a 5 mm. ball, gives a reading between 33 and 37. The thermal conductivity is very poor, and the material can almost be classed as a heat insulator. The modulus of elasticity differs on tension and compression, and the material has a very pronounced hysteresis loop under stress, with a very slow time recovery. The stress-strain curve lacks the well defined yield point of metals, and does not appear to follow Hooke's law. Typical curves for paper base synthetic material. Some points that can be placed in favour of plastic materials : (1) The material is light and can be easily handled ; (2) Has the requisite strength ; (3) smooth bearing surface ; (4) good load carrying capacity ; (5) high resistance to impact ; (6) can be lubricated by any medium ; (7) non-scoring properties ; (8) low coefficient of friction ; (9) low thermal conductivity ; (10) low modulus of elasticity, minimizing high concentraction of load ; (11) hard wearing, its disadvantages include—(12) poor heat conductor ; (13) low temperature range of operation ; (14) experience of operators ; (15) initial cost application ; (16) no scrap value ; (17) not a universal application. Illustrations : Bearing cages made from bakelite laminated. Bearings machined from tube and used on a fan in a large gas-producing plant. Stainless steel strip mill fitted with bakelite laminated bearings. Bearings machined from bakelite laminated and fitted to hot rod mill.

Inconel (Henry Wiggin & Co. Ltd.).

Inconel is a corrosion-resisting alloy containing approximately 80% nickel, 12 to 14% chromium, balance mainly iron. Nickel contributes in high degree to its resistance to corrosion by a great many inorganic and organic compounds throughout a wide range of acidity and alkalinity. Chromium confers the ability to remain bright under exposure to sulphur compounds in the atmosphere or in other corrosives ; it also provides resistance to oxidising atmospheres at elevated temperatures and to oxidising conditions in corrosive solutions. Physical constants, mechanical properties, castings. Ultimate strength, 32.0 tons/sq. in. ; yield point, 18.0 tons/sq. in. ; elongation, 10-15% on $4\sqrt{\text{area}}$; brinell hardness, 160 approx. High temperature properties. Properties in compression. Properties in shear. Torsional properties. Impact toughness. Fatigue strength. Spring properties. *Corrosion resistances.* Atmospheric corrosion. Fresh water. Salt water. Neutral and alkaline salts. Oxidising acid salts. Oxidising alkaline salts. Mineral acids. Oxidising acids. Organic acids and compounds. Alkalies. Wet and dry gases. *Typical uses* : Food manufacture. Chemical and process industries. Photographic. Textile industry. *Fabrication* : Forging. Rolling and drawing Machining. Annealing. Pickling. Joining.

MEASURING METHODS AND APPARATUS.

The Sine Bar—and How it is Used. (*Practical Engineering, January 27, 1940, Vol. 1, No. 1, p. 36, 4 figs.*).

Standard sine bars are made in two lengths—10 in. and 5 in. – the equivalent measurement to build it up to the angle required is found by multiplying the sine given in engineering text-books by the length of the sine bar being used. Illustrated are an ordinary instrument as made by most of the leading precision tool manufacturers. An improved sine bar. An angle plate with sine bar in position.

The Measurement of Surface Temperatures. (*Mechanical World, December 29, 1939, Vol. 106, No. 2765, p. 591, 3 figs.*).

The accurate determination of the temperature of heated surfaces is a subject of great importance in both industrial and research practice. Thermocouple specially designed for measuring the cylinder head temperatures of internal-combustion engines. Sparking plug thermocouple in position on an aeroplane engine. Contact with the surface. An example of a bow-type pyrometer with indicator.

MECHANICS, MATHEMATICS.

Dynamic Balancing. (*J. Craig Jones, Aircraft Production, Vol. 1, No. 14, December, 1939, p. 484*).

Having discussed the theory of balancing and the most common methods for determining out-of-balance, the Olsen "E.O." type balancing machine is described. This works on an entirely new principle and is capable of handling exceptionally small parts. The machine is made in several sizes, the smallest size being capable of handling parts weighing a maximum of 5 lb. and a minimum of 5 oz. This type of balancing machine is capable of denoting the amount and position of out-of-balance weight by either mechanical or electrical means.

PSYCHOLOGICAL INVESTIGATION.

Tools of the Personnel Trade, by Guy W. Wadsworth, Junr. (*Mechanical Engineering, January, 1940, Vol. 62, No. 1, p. 13*).

Personnel work justified itself as a speciality only as it produces results superior to those which can be obtained otherwise. Unless the personnel man can select better workers than would be hired by department heads, and deal more efficiently with promotions, transfers, and like problems, there may be no special virtue in centralizing personnel functions. The fact that few firms take the trouble to keep comprehensive records no doubt explains the prevalence of many beliefs which spring up and flourish unchallenged in the employment field. Once we can measure results with some assurance, the appraisal and improvement of our hiring techniques can be objectively undertaken. Personnel-interview method of hiring. "Reading the candidate's character." Examination techniques. Value of psychology tests. Studying occupational intelligence levels. Results of hiring by mental-ability-test standards. Measuring personality. Improve selection methods.

SMALL TOOLS.

Low Cost Tools for Limited Production, by C. W. Hinman. (*The Machinist, January 6, 1940, Vol. 83, No. 48, p. 959, 6 figs.*).

Small shops have need continually for cheap tools that will not be an excessive burden on small-lot orders. Examples given are for progressive piercing,

forming and cutting-off tools, for adjustable die holders, for an automatic stop, and tools to be used in vice or shaper. Such tools are built in great variety of designs for rapidly producing such small articles as radio parts, telephone switch-board braces, and brackets for assembling furniture. In a progressive die, the blank is confined between two plane faces, so that the bends are located accurately. In an alternate design the cut blank is prevented from creeping by three pins actuated by compression springs. An inserted cutting-off blade is often a valuable feature because it can be lowered after grinding the angular edges. About three dozen adjustable die holders will be found sufficient for mounting as many as 300 temporary dies as they are required in the shop. Grinding or peening the point face of a pawl-type automatic stop will alter the blanking length when necessary. A bench vice often provides the means of making quantities of small parts from 1/32 to 1/16 in. brass stock. A shaper is a convenient machine upon which to set-up several types of press tools for simple die operations.

Cutting Steel with Carbide, by James R. Longwell. (*The Machinist, December 30, 1939, Vol. 83, No. 47, p. 952, 13 figs.*).

Tools designed according to standardised data are recommended for use when steel is to be machined with Carboloy tipped tools. Nomenclature (A.S.A.) used for single-point tool elements. Coolant should be directed under pressure from beneath the tool, or from each side, so that the rapidly forming chip will not prevent the stream from reaching the cutting edge. Chip breaking or curling grooves ground in the face of the tool tip frequently are sufficient. Tool holders. Sufficient power *must* be provided before attempting to use carbide tools. When using a belt-driven machine, be sure that proper width belts and pulleys are used. It is necessary to have room to handle the increased volume of chips. This is an especially important consideration on multiple-tool set ups, as the additional chip handling problems at higher speeds sometimes will more than offset the time saved on a maching operation.

SURFACE TREATMENT.

Surface Protection. (*Aircraft Production, February, 1940, Vol. 2, No. 2, p. 45, 1 fig.*).

A survey of the Parkerizing and Pyluminizing processes in aircraft works. Resistance to corrosion. Fatigue strength. Established uses of phosphate treatment. Phosphate treatment as a key for paints. Pylumin process for the protection of aluminium.

Chrome Hardening. (*Automobile Engineer, December, 1939, Vol. 29, No. 392, p. 453*).

Electro deposition as an antidote to cylinder wear. Bench tests. Graphs of cylinder and piston ring wear. Wear caused by inferior grades of fuel oils is well known in the Diesel engine industry. Tests on bores and rings. Special tests. The withholding of oil supply during the preliminary five minute idling period of each fifteen minutes run, so that during this initial low-temperature portion of the cycle the only lubrication available was that left on the cylinder walls from the previous cycle. Results are shown summarised in a table.

Phosphatising. (*Automobile Engineer, December, 1940, Vol. 39, No. 392, p. 459*).

Practically all the engineering concerns interested productively in the automobile industry, employ one or other of the phosphatising processes for the pre-treatment of iron and steel work prior to enamelling. The progress

of the tests is summarised in the two tables which deal with the spot-welded sheets and sections respectively. For both classes of component the specimens have the full treatment of phosphatising and chromate rinse showed markedly superior performance. It can be concluded that the phosphatising treatment in itself furnished very sound durability, but the increased protective value provided by the chromate rinse more than justifies its inclusion.

WELDING, BRAZING.

Welded Tankwork : Some Influencing Factors, by J. K. Johannesen. (*The Welding, January, 1940, Vol. 7, No. 12, p. 417, 5 figs.*).

Certain fundamental conditions must be fully observed, as material, design, production and service. One tank structure in its application to several examples illustrates each of these individual factors and trace its effects. Top plat sections. Tank end circumferential sections at various points. Assembly of welded fertiliser extractor. Assembly of all-welded filter box with portable top-plate removed. Steam jacket repair.

Study Step Welds for Profit, by E. W. P. Smith. (*The Machinist, December* 16, 1939, *Vol.* 83, *No.* 45, *p.* 906, 2 *figs.*).

Analysis of the three cost factors : The actual arc time, the set-up time and the time which is accounted for ; application of the study.

The Training of Welders, by H. Martin. (*The Welding, January,* 1940, *Vol.* 7, *No.* 12, *p.* 437).

Problems of a growing industry. Variety of training schemes. Suggested groups for training : Group " A "—arc welding—mild steel—all thicknesses above 3/16 in. Downhand and vertical butts and fillets. Group " B " as above, plus one of the following : (1) Staybrite 20 gauge to 3/16 in. ; (2) non-ferrous welds, aluminium, copper bronze ; (3) welding of alloy steels ; (4) overhead butts and fillets on mild steel ; (5) special applications, straight gap, butt, welds, etc. ; (6) mild steel 20 gauge to 3/16 in. Cost of training welders. Examination of welds. The method of training. Supervisors and designers.

Research Department : Production Engineering Abstracts

(Edited by the Director of Research).

ACCOUNTING ADMINISTRATION.

Budgeting Inventories and Stabilizing Employment, by P. K. Poulton and P. H. Goldsmith. (*Factory Management and Maintenance, December, 1939, Vol. 97, No. 12, p. 52, 1 fig., 1 chart*).

Vitally important to any business are its policies for smoothing out employment curves, thus providing its employees with the security of steady incomes. But employment can only be steady when production moves along at an even pace and, as the authors point out, one factor that has a lot to do with whether production fluctuates or not, is inventories. Let raw material inventories get too low, and production waits for materials. Let finished goods pile up and production must wait for sales to catch up. The authors believe that the answer to both the financial and social aspects of this problem can be found in a well-organised well-planned and well-controlled inventory turnover. Budgetary control is the means of carrying out this policy, and may therefore be a cogent expression of a company s industrial relations policies. Knowing what inventory turnover is desirable, budgets for ten years ahead can be planned to determine what figures for sales and inventory should be aimed at. A monthly budget for ten years ahead, based on desired inventory turnover. Breakdown of raw material budget by types of major materials is made on a monthly basis. This brings to light classes of materials whose turnover is below average, and which therefore require special attention so that rate turnover can be speeded up. Chart for ten-year period gives the inventory picture in its relation to sales. It can be seen that inventory went down, inventory turnover up, when budgetary control was introduced.

BELTS AND ROPES.

The Importance of Belt Splices, by H. Stuart Jude. (*Power Transmission, February, 1940, Vol. 9, No. 97, p. 26, 6 figs.*).

Leather splices. Cements for leather belting. Balata belting. Rubber belting. Splice design in ply belts. All splicing methods are built upon two basic ideas—uniformity of thickness and uninterrupted passage in travel. Every splice must have a toe and a heel, whether the whole thickness is scarfed or stepped down in a series of butt joints.

COOLANT, LUBRICANT.

The Influence of Various Lubricants on the Seizure Characteristics of Hard Steel and Bronze, by D. Clayton. (*Engineering, February 9, 1940, Vol. 149, No. 3865, p. 131, 7 figs.*).

The behaviour of a cutting oil and its emulsion, and related tests with water and no lubricant, using hard steel balls. Results are given for bronze balls, and for combinations of bronze and steel balls, using first, ordinary lubricants of several types and then, in the case of bronze and steel together, the thin liquids petrol and water. Conclusions : With steel balls the oil provides a large measure of protection in the low-load range. With water, boundary

film of the same kind is not formed, and fine wear to a greater extent takes place. The thin liquids, possibly by allowing some action on the surface at the beginning of the test, or possibly by their better cooling effects, have some relatively beneficial quality at this stage. When a steel ball rubs on bronze balls, the yield by the softer materials is of considerable importance, as it is with bearing metals in journal bearings. Very high loads can be taken without seizure, and the lubricant has little effect, possibly because the yielding has allowed a fluid film to form. The relative wear of the rotating and stationary balls depends on the material, and with bronze and steel together the lubricant affects the bronze, picking up fine steel particles which in continued running, would probably have a lapping action.

FOUNDRY, MOULDING.

Aluminium-bronze Gravity Die Casting, by Dr. Arthur Street. (*Engineering February 16, 1940, Vol. 149, No. 3866, p. 159, 7 figs.*).

The Durville process. The equilibrium diagram of the copper-rich copper aluminium alloys. The addition of aluminium to copper results in a considerable improvement in the resistance to corrosion and many of the uses of aluminium-bronze are due to this property. A comparison of the corrosion resistance properties of aluminium-bronze with those of other non-ferrous alloys. Lastly, fabrication methods such as hot and cold rolling, forging, centrifugal casting, and die-casting have been applied to aluminium bronze and it has been found that, by the use of these methods, considerably improved physical properties can be attained. Castings for underground railway equipment. Castings for automatic machines. Properties of aluminium-bronze. Table I : Corrosion of non-ferrous alloys in aerated solutions at 60°F. Table II : Effect of quenching on Brinell-harness numbers of aluminium-bronze (Matsuda). Table III : Effect of quenching from various temperatures on tensile strength, elongation, and notched-bar impact strength, of aluminium bronze containing 9.77% aluminium. Table IV : Mechanical properties of aluminium-bronze rod after quenching and tempering (90.3% copper, 9.4% aluminium, 0.2% managanese). Diamond-pyramid hardness. Limit of proportionality. Proof stress (0.1%). Tensile strength. Elongation. Per cent. on 2 in.

GEARING.

Epicyclic Gear Analysis—Part II, by A. B. White. (*Power Transmission February, 1940, Vol. 9, No. 97, p. 12, 5 figs.*).

External type trains. Internal type Gears. Composite type gears (internal and external teeth). Bevel epicyclic trains.

Noisy Gears are Out, by R. R. Weise. (*The Machinist, February 10, 1940, Vol. 83, No. 53, p. 1067*).

Noisy gears cannot be tolerated in the modern tractor. That is why International Harvester has instituted complete laboratory control of material selection, gear production processes, and heat-treatment at its Milwaikee plant. Some 30,000 gears are turned out every week. A gear laboratory insures that the best possible production methods are used to achieve the required quiet operation of gears. All spur gears are lapped prior to final speed testing and matching. Red line speeders show up noisy gears. Bevel gears are unloaded from the gas-fired furnace by hand and transferred to Gregg-Logan quenching machines. Materials used and their testing. Forge shop. Operation procedures for typical tractor gears. (1) Metallurgical

laboratory. (2) Forge shop. (3) Gear blanking department. (4) Gear cutting department. (5) Gear laboratory. (6) Heat-treating department. (7) Gear blanking department. (8) Gear laboratory.

HEATING, VENTILATION.

The Significance of Air Movement in Timber Drying Kilns, by W. C. Stevens (*Journal of the Institution of Heating and Ventilating Engineers, December 1939, Vol. 7, No. 82, p. 405, 3 figs.*).

In the drying of timber, the actual rate at which moisture is extracted from the various portions of the material considerably affects the final quality and condition of the seasoned wood. Rapid drying of the surface, for instance, frequently leads to induced internal stressing of the timber which may in turn cause it to split or distort. Factors that considerably influence the rate at which moisture can be extracted and evaporated from the wood in this manner are (1) the temperature (2) the humidity, and (3) the direction and rate of flow of air over the surfaces of boards to be dried. Cross section of overhead internal fan kiln showing air circulation. The described tests and calculations illustrate clearly the importance of maintaining a good uniform air flow through a pile of timber in a drying kiln, and show that variations in the average air speed between rows, up to a speed of about 2 ft. per second, may very considerably influence the rate of drying of each and every board in the pile quite irrespective of the temperature and humidity conditions of the air at entry. The method of estimating the average air speed through a pile by determining the speed of smoke introduced into the air stream and multiplying by five eighths appears to be quite satisfactory, and can be generally recommended for practical use in timber-drying kilns.

Heating with High-temperature Water. (*The Heating and Ventilating Engineer, January, 1940, Vol. XIII, No. 151, p. 292, 10 figs.*).

The advantages of hot-water heating with forced circulation as compared with steam heating must become more pronounced at higher temperatures. These advantages may be summarised as follows. (1) When heating with high-temperature water the heat is transmitted to the consumer by means of superheated water circulated by electrically and mechanically driven pumps. (2) Heating by means of superheated water is effected in a totally closed system not open to the atmosphere at any point. The only losses that occur are those in insulated pipes and fittings, and these losses are small. (3) The easy regulation of temperature in a high-temperature hot-water system is a feature in which it shows to great advantage over a steam-heating system. (4) One of the principal advantages of a heating system with high temperature water, and one which plays an essential part in the uniformity of heat distribution, is its great capacity for storing heat. (5) In a high temperature water installation, the quantity of make-up required is limited to the replacement of the slight losses of water through the stuffing-boxes of pumps and valves, etc. (6) In contrast to a steam and condensate pipe system, high-temperature water pipes may be erected without paying any great attention to gradients ; drainage points with their accompanying steam traps are also eliminated. Many interesting illustrations of well made plants (Sulzer Bros., London).

JIGS AND FIXTURES.

Universal Drill Jigs, by J. I. K. (*Machinery, February 1, 1940, Vol. 55, No. 1425, p. 465, 9 figs.*).

Factors to be considered when designing drill jigs that combine economy

with operating efficiency. A typical example of a top-plate blank. An adapter blank of common design. An example where two holes are added to an existing top plate. It is shown in a given instance that by adding one hole to an existing jig plate the cost of a new plate was saved. Diagram illustrating design of adapter when the finished side of the work faces the top plate. Design of adapter used when the finished side work faces the adapter. Speed of operation with universal drill jigs. Interchangeability of universal drill jigs. Tool and design costs saved by using universal drill jigs. Savings in time-study cost. Where are universal drill jigs used to best advantage. The design of universal jigs. The location of the components in a universal drill jig. Locating work concentrically. Concentric internal location from the top plate. Sample of work that requires internal concentric location. Example of concentric location of work from the top plate. Design of top plate and adapter when locating from the adpter. Concentric internal location from the adapter.

KINEMATICS.

The Harmonic Motion Cam, by W. Richards. (*Machinery, February 1, 1940, Vol. 55, No. 1425, p. 481, 3 figs.*).

Simple harmonic motion. Diagrams illustrating simple harmonic motion. Derivation of the harmonic motion cam profile. Derivation, from crank motion, of a cam profile which will impart simple harmonic motion to the follower. Technical design of the harmonic motion cam. Velocity, acceleration, and retardation. Simple harmonic motion cam layout. Technical analysis of the harmonic motion cam. Pressure angle.

MACHINE ELEMENTS.

General Bearing Practice of Timken Tapered Roller Bearings, by Mr. E. H. Doughty. (*Timken Times, Vol. 1, No. 3, p. 2, 8 figs.*).

The mounting requirements for thrust load conditions. The most suitable types of bearing are the steep angle or high thrust bearings, and the flat thrust heavy duty bearing. The steep angle bearing is, practically without exception, used for all high-speed thrust applications. Typical applications for which this type is suitable, include centrigufal pumps, marine thrust blocks, thrust blocks for tube piercing mill mandrels, bevel gears, worm gears, screw mountings, lathe tailstock centres, and lead screws, footsteps for vertical shafts, crane posts, derricks, and davits, and many other similar applications. The flat thread heavy duty bearing is not usually employed for speeds over 125 r.p.m. for medium sizes, the speed decreasing with the larger sizes. Such slow speed applications are particularly suitable for crane hooks, locomotive turntables, swing bridge pivots, railway bogie pivots, heavy duty screw gearing, footsteps for crane posts, and derricks, etc. The smaller sizes are largely used for the steering pivots of commercial vehicles. Illustrations show steep angle bearings for (1) worm gear drive (2) piercing mill thrust block (3) a vertical centrifugal pump. Flat thrust bearings are shown : I—*Bearing axis vertical* (*a*) intermittent rotation (1) light crane hooks (2) heavy crane hooks ; (*b*) constant rotation (slow speed). In all continuously revolving applications, which in the case of medium size bearings, should not normally exceed 125 r.p.m., it is necessary to provide a separate radial bearing, as the Timken thrust bearings has no radial capacity. II—*Bearing axis horizontal* a revolving race for a tailstock is illustrated.

Bearing Mounting Practice of Tapered Roller Bearings, by E. H. Doughty. (*Power Transmission, February, 1940, Vol. 9, No. 97, p. 23, 11 figs.*).

Radial load conditions. Two methods of mounting : (*a*) The " indirect "

in which the small ends of the rollers point inwards, and (*b*) the " direct " which is the reverse of (*a*). Illustrations of direct mounting and indirect mounting. Conditions controlling the mounting. Cases where a compromise is necessary. Details to be studied in design.

MACHINE TOLLS.

Novel Honing and Lapping Machine. (*Mechanical World, February 16, 1940, Vol. CVII, No. 2772, p. 142*).

Hydraulic speed and reciprocation control. General view of the Kitchen and Wade honing and lapping machine showing arrangement of controls.

Portable Grinding and Lapping Machine for Tungsten-carbide Tools. (*Engineering, January 5, 1940, Vol. 149, No. 3860, p. 21, 1 fig.*).

The small portable grinding and lapping machine has been designed by Messrs. Van Dorn Electric Tools, Slough, for the maintenance of cutting tools tipped with the different types of tungsten-carbide hard metals. The re-sharpening is done by a Norton diamond-impregnated cup wheel, 3 in. in diameter by $\frac{3}{4}$ in. wide by $\frac{1}{8}$ in. edge. The wheel is mounted directly on the motor spindle, the speed being 7,500 r.p.m., which gives the correct surface speed for the diameter and grain. The tool rest is adjustable so that it can be set at the correct angle, viz., that coinciding with the clearance angle of the tool to be ground. This is important, since undue wear of the diamond wheel would result if the tool were not held flat against the wheel surface. No coolant or cutting lubricant is required, and the cutting surface of the wheel can be readily cleaned and restored to its original sharpness by dressing it lightly with a piece of pumice stone or with a fine and soft crystolon stick.

Curved-tooth Bevel-gear Generating Machines. (*Engineering, January 26, 1940, Vol. 149, No. 3863, p. 82, 13 figs*)..

" Curved-tooth " is here used to distinguish gears in which the tooth is curved along its length apart from any curvature arising from an angular disposition of the teeth on the pitch cone. The operating principle of Gleason's curved-tooth gear-cutting machines—the hypoid generator. The machine employs a relative rolling motion between the cutter and the pinion or gear wheel being cut, the latter having teeth of involute profile. The machine will cut ordinary curved-tooth spiral pinions and gear wheels, i.e. those in which the axes of the pinion and wheel are coincident. A somewhat similar machine has also a circular cutter for the cutting of what are known as " formate " bevel-gear wheels, that is, wheels which have curved teeth with straight flanks, and it does not employ a generating motion. The reasons for the increasing popularity of curved tooth bevel gears is that the gears continue to run without load concentration, a condition it is claimed only obtainable with curved teeth. The curved tooth bevel gear is stronger than one having straight teeth. The most recent development in bevel gearing is that of employing curved teeth with no spiral angle at all. The term " zerol " is applied to such gears from their having zero degree spiral angle. The gear partakes of the characteristics of both the straight tooth bevel gear and the curved tooth bevel gear. The gears can be ground after hardening in order to eliminate any distortion and to secure the accuracy and uniformity required for the even distribution of the load over many pinions. The formate gears run as smoothly and quietly as generated gears, and are equally strong and durable, while the operation is the fastest method of gear finishing. The hypoid curved tooth gear enabled lower bodies to be fitted to motor cars. The hypoid gear is generally similar to a curved tooth spiral gear, and may, of course, but cut

and, in some cases, ground, by either the generating or formate method on the same machines that are used for spiral bevel gears with coincident axes. The fatigue life of a pair of hypoid gears is stated to be at least four times greater than that of a corresponding pair of coincident axis spiral bevel gears The machines concerned are briefly described.

Semi-automatic Folding and Forming Machine. (*Machinery, Lloyd, February 10, 1940, Vol. XII, No. 3, page 20, 3 figs.*).

Description and illustrations refer to one of the Fairbank Brearley semi automatic universal folding and forming machines for handling 6 ft. by 16 gauge sheets. Example of right angled bends. Example of radius bends.

MANUFACTURING.

Modern Precision Grinding Methods, by R. Brulé. (*Aircraft Engineering, February, 1940, Vol. XII, No. 132, p. 49, 29 figs.*).

Finishing operations as carried out in Hispano Suiza production. Truing up a grinding wheel. The method of attack of a grinding wheel. Refacing a grinding wheel by diamond. Grinding between centres. Centreless grinding. Grinding the cams of an air cooled engine by the plunge cut method. The components of the movement of the part being worked, using a hyperboloid grinding wheel. Examples for the five methods: (*a*) Grinding in series; (*b*) plunge cut grinding; (*c*) end grinding; (*d*) grinding by shaped grinding wheels; (*e*) internal grinding. Plane or surface grinding. Thread cutting and the forming of threads by grinding. A finishing and thread cutting grinding machine made by the Coventry Gauge and Tool Co. The checking of thread grinding is effected by the optical method with a Jones & Lamson comparator. The machining of elastic cylinder joints.

Boring Elliptical Holes, by Francis W. Shaw. (*Mechanical World, February 23, 1940, Vol. CVII, No. 2773, p. 162*).

The possibility of boring rotary vane pump casings to elliptical form as a close approximation to the theoretical form (curtate epitrochoid). As an inclined cutter bar rotates, the object being bored travels in the horizontal direction, it is manifest that the elliptical form will be maintained throughout the bore. Any sliding lathe may be made the basis of a suitable arrangement if the headstock can be inclined in plan to the lathe bed. Determining the boring bar setting. Plan view of elliptical boring apparatus.

Special Types of Breeches Pieces, by W. Cookson. (*Sheet Metal Industries, February, 1940, Vol. 14, No. 154, p. 166, 4 figs.*).

There are occasions when it is necessary to make an air duct breeches piece with a flush side, to enable the job to lie flat against a wall or bulkhead. Pattern for flush sided breeches piece. Construction of lay out. Description of an alternative lay out. Pattern for flush sided breeches with parallel ends. Drafting the pattern. Pattern for two way transitional elbow.

Lapping for Final Finish, by H. J. Wills. (*The Machinist, February 10 1940, Vol. 83, No. 53, p. 1080, 3 figs.*).

By lapping it is economically possible to remove cutter and chatter marks from gears, correct small imperfections in profile and spacing, correct distortion caused by heat treating, and reduce friction to a minimum when the gears are in operation. After the gear starts rotating, the lapping compound is applied with a brush. If the production of gears is small or intermittent, or

if lapping equipment is not available, gears of all kinds can be satisfactorily lapped by assembling them and running them in their cases with proper compound. Lapping compounds suitable for lapping hardened steel gears are given. Crankshafts can be lapped inexpensively with a leather lined " nut cracker." Where quantities warrant, best results are obtained from machines especially designed for lapping. This bevel gear lapper is a good example. Flat surfaces may be lapped by mounting on a ball bearing work holder under an offset spindle holding the lap.

Heinkel Production Methods, by A. Thormann and H. Jockish. (*Aircraft Production, March, 1940, Vol. II, No. 3, 23 figs.*).

New methods of manufacture designed to reduce costs of production in the Heinkel works. Modifying tube sections. Diagrammatic view of an outside drawing or contracting tool. Illustrating the formula for calculating the contracting pressure for thin walled tubing. Curves showing the relationship which exists between the contracting pressure and the contraction angle for different frictional characteristics. Cross sectional changes when contracting duralumin tubes from 50, 45, 40, and 35 mm. diameter down to 20 mm. diameter. Control rod end in which the " eye " is formed integrally with a threaded shank, screwing into a rolled-in thread in the tube. Method of loading tubes for buckling and tensile tests. Use of commercial tubing. Strength of experimental tubes before and after testing. Examples of flanged duralumin tubes. Testing tubes with rolled threads. Various stages in mushroom head riveting. Pneumatic mushroom riveting tool. Dolly, dimpling, and cutting off tools are all combined in one. A special type of dolly for use where accessibility is restricted, as inside stiffener or stringer sections. Various stages in flush riveting with countersunk and dimpled sheets, beginning with drilling and countersinking and continuing with insertion, dimpling, and final driving. Flush riveting by using a flat dolly and driving in the sheets. This method is not recommended for highly stressed parts. A specially developed hand creasing tool. A tool counter sinking holes in components in position. Multi-spindle drill heads for attachment to standard drilling machines. Tools for creasing thin sheet.

The Production of Shell Fuse Components. (*Machinery, February 8, 1940, Vol. 55, No. 1426, p. 493, 15 figs.*).

General arrangement of the fuse, without the mechanism. Tool layout for the first maching operation on the fuse body. Tool layouts for the first and second operations on the body. Diagram illustrating the principle of the screw thread comparator employed. Tool layout for the first maching operation on the fuse cap.

MATERIALS, MATERIAL TESTING.

The Magnesium Alloys. (*Mechanical World, February 2, 1940, Vol. CVII No. 2770, p. 91, 4 figs.*).

The pure metal. General characteristics of the alloys. Graphs of magnesium aluminium alloy, magnesium zinc alloy, magnesium manganese alloy, magnesium cerium alloy. The alloys with manganese. Compositions of standard magnesium alloys. Specifications of reference : % Al, % Zn, % Mn, % Cu, % Si ; total other impurities %. Mechanical properties of magnesium alloys. Specification or other reference : 0.1% proof stress (tons/s in.), tensile strength (tons/s in.), % elongation, Brinell hardness. The alloys with Cerium additions.

Synthetic Materials as Bearings for Mills, by C. D. Philippe. (*Engineering January 26, 1940, Vol. 149, No. 3863, p. 99, 3 figs.*).

The laminated material used in bearings is made up of two parts, the bonding material, which is the phenoformaldehyde resinoid, and the filler, which, in this case, is a woven cotton cloth. The material is hard, infusible, insoluble, stable and very non-hygroscopic, although it does absorb a very small percentage of water on its surface only. Its specific gravity is 1.35. It fills the gap between wood and the light metal alloys. The tensile strength across the face in two directions is between 4 and 5 tons per sq. in. Its shear strength through the laminations is between 4 and 5 tons per sq. in., while its compressive strength flatwise is somewhere near 18 tons on a 1 in. cube. Table I gives comparative values for metal alloys, plastics and wood. Table II compares favourably with other materials : stainless steel, aluminium alloy, magnesium alloy, aircraft spruce, phenolic resin fabric filler, phenolic resin paper filler, phenolic resin cord filler. The load carrying capacity is generally higher than that of metals. The sub divisions given in Table III have been suggested for pressures and rubbing speeds. For the best results, due consideration must be given to the question of lubrication.

Preparation of Metals in a Compact Form by Pressing and Sintering, by J. D. Fast (*Philips Tech. Rev., November, 1939, p. 310*) (*Met. Vickers Tech. News Bulletin, No. 690, December 22, 1939, p. 9, 8 figs.*).

Due to their high melting points, the metals tungsten, molybdenum, tantalum, etc., cannot easily be melted or cast. These metals can however, be prepared in powder form. This article describes the preparation of the compact metal, by methods of powder metallurgy. A general discussion is given of the preparation and working of ductile tungsten for the electric lamp industry and the preparation and use of hard cemented carbides as cutting tools is reviewed. The use of self lubricating bearings, prepared by powder metallurgical methods, is noted.

MEASURING METHODS, APPARATUS.

Precision Optical Apparatus. (*The Engineer, January 26, 1940, Vol. CLXIX No. 4385, p. 92, 5 figs.*).

Electrical and optical precision instruments made at the works of Taylor, Taylor & Hobson, Ltd., Leicester. The "Electrolimit" gauge measures by mechanical contact, the readings being electrically magnified. It has the particular advantage of being adjustable for large magnifications, and is subject to no detrimental wear, which enables it to be used in the inspection of mass production parts to a degree of accuracy normally obtainable only with master gauges. The range of magnification with these instruments is from about 800 to 1, to 13,000 to 1, giving full scale readings for 0.004 to 0.00025 in. One small division will be $\frac{0.00025}{60} = 0.0000042$ or approximately 4 millionths of an inch. A Profile projector has a projection length of 200 in., and its optical combinations give magnifications from 20 to 100 times the size of the original, the focal lengths being from 2 to 10 in. The alignment telescope consists of two units, the telescope and a collimator. The construction of the collimator is similar to that of the telescope to ensure coincidence of the mechanical and optical axes. For the measurement of displacement the collimator carries a sighting target, mounted in front of the lens. Systematic observations of displacement and tilt can be made in two meridians at right angles. Sighting targets are also supplied mounted in separate plugs for the purpose of making displacement measurements only. The relative tilt of a pair of bearings can be measured to within one-fifth of a scale division of six seconds of arc, and this accuracy can be maintained at separations of

100 ft. in still air. The section projector was designed for the purpose of obtaining sections of work which cannot be projected with the normal profile projector, as for example, an axial section of a thread having a large helix angle, or a worm wheel, or helical bevel gear.

Equipment for Measuring Surface Temperature. (*Mechanical World, January 5, 1940, Vol. C VII, No. 2766, p. 6, 8 figs.*).

Using a hand thermocouple for taking the temperature of a calender roll. A special instrument for taking the temperature of internal surfaces. An instrument for taking temperatures of radiating fins. An extensible pyrometer for use in cylinders. Bakelite moulding press showing method of taking temperatures. Measuring the temperature of the lagging on a steam pipe.

MECHANICS, MATHEMATICS.

Problems Involving Compound Angles, by C.B. (*Machinery, February 8, 1940, Vol. 55, No. 1426, p. 501, 20 figs.*).

Effect of tilting a triangle about an axis at right angles to the plane of the paper. Effect of tilting the triangle about a horizontal axis in the plane of the paper. Effect of turning a triangle about a vertical axis in the plane of the paper. Effect of tilting a triangle successively about horizontal axes in the plane of the paper and at right angles thereto. Effect of successively turning a triangle about a vertical axis in the plane of the paper, and tilting it about a horizontal axis in that plane. One method of setting a compound angle block so that the upper surface is horizontal. Compound angle block set-up with the aid of a compound tilting table. Compound angle block set-up by successive turning and tilting. A block having a compound-angle V-groove. Block with compound-angle V-groove set-up by successive turning, tilting and turning movements. Block with compound-angle V-groove set-up on compound tilting table. With this method the edge is not finally parallel to the direction of machine table movement. Block with compound-angle V-groove set-up on a compound tilting table so as to bring the directing edge parallel to the direction of the machine table movement. Block with compound-angle dovetail groove. Method of setting a given tilted block so as to bring the side surface of the groove into the vertical plane. Set-up on a compound tilting table for grinding the bottom surface of the groove. Compound-angle block having an inclined groove on the upper surface. Diagram showing how the true angle of elevation of any line on the surface of a compound-angle block may be obtained.

RESEARCH.

Motion Study Research, by Ralph M. Barnes and Marvin E. Mundel. (*Factory Management and Maintenance, December, 1939, Vol. 97, No. 12, p. 56, 4 figs.*).

A study of simultaneous, symmetrical hand motions with both terminal points and paths of motion fixed, times for fundamental hands motions are found to differ from those obtained when terminal points alone were fixed. Arrangement of the workplace when both the terminal points and paths of motion were fixed by slides. Only one arrangement is shown—the motion path of each hand makes an angle of 60° with the plane of the front of the operator's body. Wiring diagram of the slides and auxiliary equipment used in this study. The kymograph record. When slides reach limits of their travel, jogs are made in the lines on the record. Graph of the average times of individuals, the whole group, and of the slowest and fastest sections of the group. Eye-hand co-ordination. Result sheet.

SMALL TOOLS.

Hot Shear Blades, by M. Riddihough. (*The Welding Industry, February 1940, Vol. VIII, No. 1, p. 13, 4 figs.*).

Cutting alloys applied by welding. The application of a layer of special cutting alloy to the edge of the blade is perhaps not a new idea, but it has only become practicable by the development of an alloy which retains its hardness at the high temperature brought about by contact with the hot billet and which has sufficient toughness to withstand the impact of the cut. These requirements are filled by the softest of the group of Deloro Stellite alloys. The softest Stellite has a low tungsten content and shows no free carbides. It has a pyramid diamond hardness of 400° and again is unaffected by heat treatment. This latter alloy is welded on to the edge of shear blades using the oxy-acetylene torch. Mild steel or cast steel blades are recessed and blades over 3 ft. long are preheated to a dull red heat; shorter blades are welded without preheating. Sufficient thickness of Stellite is applied to allow finish grinding to $^{2}/_{32}$ in. thick, and the blades should be cooled slowly. The blades are finally ground with a soft coarse wheel 38 or 46 grit (I or J, Norton) bond, running at slow speed of from 3,000 to 4,000 surface feet per minute. The cutting edge retains its sharpness for the greater period of its life between grinds which may be 25 times that of ordinary steel blades.

Outils Divers (Various Tools), by M. Scherer. (*La Machine Moderne February 1940 Vol. XXXIV No. 380 p. 59, 56 figs.*).

Tables and drawings of standardised single cutting tools giving the angle of: Clearance, top-rake, plan for the important types: (1) Roughing and finishing cylinders; (2) facing planes; (3) parting; (4) forming; (5) threading.

More Metal Per Grind, by F. Deak. (*The Machinist, February 3, 1940 Vol. 83, No. 52, p. 1041, 10 figs.*).

Tungsten carbide tools, do not eliminate the use of these other cutting materials which will continue to be in demand because of their adaptability to certain applications. Sintered carbide tools, correctly used, will give excellent results in machining such materials as cast iron, malleable iron, bronze, brass, fibre and laminated plastics. Chilled cast iron, extremely hard, has also been successfully machined with sintered carbide tipped tools. Since the introduction of tungsten-titanium, tungsten-tantalum and tungsten-titanium-tantalum carbides, 40-50 carbon steel heat-treated as high as 310 Brinell, nickel steel and high manganese steel have been machined successfully with carbide-tipped tools. The illustrations show the correct cutting angles for: (1) Hard chilled cast iron for both boring mill and lathe operations; (2) high-speed steel tool tips with chip breakers for turning soft steel; (3) tough but soft forged steel, axle steels and nickel steels to be turned with this tungsten-titanium carbide tipped tool. A 12° chip breaker is satisfactory for turning 40-50 carbon forged steel heat-treated to 285-300 Brinell hardness with tungsten-titanium tipped tools. Other tools have breaker grooves suitable for turning nickel steel when tips are made of tungsten-tantalum carbide. Chip breaker blocks, mounted above and behind the tool tip soon wear off when cutting pressures are high. Best results are obtained when the cutting edge is set at an angle with the work especially when roughing with a heavy cut (angle of plan).

Die Design and Construction, by C.R.C. (*Machinery, December 28, 1939, Vol. 55, No. 1420, p. 331, 7 figs.*).

Die for shearing and forming tabs, and blanking. Arrangement for stripping when the tab is narrower at the end, so that it sticks in the die at the base only. Die with clearance notch for freeing the tab. A three-stage embossing, piercing, and blanking die. Two 2-stage dies, either of which can be used to produce the part made in a three-stage die shown. Die designs for different types of embossed parts. An example of flat countersinking. An example of form counter-sinking.

TECHNICAL EDUCATION.

Design and Production, by E. Ritter. (*Aircraft Engineering, February, 1940, Vol. XII, No. 132, p. 35, 11 figs.*).

A German production engineer's views on the need for co-ordination of effort and suggestions for its attainment. Design and primary planning of production. Co-operation between the designer and production engineer begins in the design stage. It is good policy to make a list of basic requirements to be borne in mind when planning new designs. Specimen of power plant mock-up with genuine wiring and pipes carefully laid out and sheet fairings made. Mock-ups. The high pitch to which materials, especially light metals, have been developed faces the production engineer with ever-growing problems. Aircraft designers have a legitimate desire for high tensile strength, but in order to ensure economy in mass production they will have to make concessions to the production engineer within certain limits. Semi-finished materials. Component parts and accessories : Leaded flange ; standardising of sections ; branch boxes ; detachable wing panel ; aeroplane door ; control bracket ; control column. In the field of fuselage things have become easier since standardization of types is beginning to make itself felt : Fuselage shell ; accuracy of wing sections. A type of construction is evolved that will permit a high standard of accuracy and possess sufficient " local rigidity." Final assembly. Beaded flanges obtained by welding and by drawing. Points for manufacturing economy. Bending of sections. Much material, wages and upkeep are saved by standardising the inner measurements of sections of varying thickness. Only a new top roller is then necessary to deal with different wall thicknesses, as against three rollers previously used. Making of branch boxes. Adapted from the practice of electrical manufacturing industries for use in aircraft wiring. Previous design—tubular ends welded. Present design—tubular ends rolled and folded. Detachable wing panel, old design. Detachable wing panel, new design. Maintenance and repair. Organisation of collaboration. The " human " factor in co-ordination. Summary : (1) Designers and production engineers must follow a line based on their common spheres of work and on a common understanding ; (2) collaboration should begin with the actual drawing of the aeroplane ; (3) the evolution of the structural elements and the working methods should be made to progress side by side ; (4) the collaboration should be organised according to some fixed plan ; (5) junior designers and production engineers must be trained ; (6) successful collaboration is based, not only on technically specialised aspects. Other factors of equal importance are Mutual understanding, consideration, an unprejudiced mind, respect for the work of the other man and, last but not least, a sense of facts as they are

A Plan of Foremanship Training, by Henry S. Jones. (*Mechanical Engineering, February, 1940, Vol. 62, No. 2, p. 135, 3 figs.*).

Modern technique of foremanship training began in the early 1920's. In

the beginning there was no sense of urgency nor necessity, but now good management recognises foremanship training as a hitherto unappreciated but extremely valuable tool. There are three methods of approach to foremanship-training programmes, through information, instruction and conference. Typical personal data card for visible-index file. First division of instruction. Primary : (1) Ideals ; (2) personnel or competent council ; (3) organisation Secondary : (1) Planning and dispatching ; (2) records, immediate, adequate, and reliable ; (3) adaptation of conditions to work ; (4) standards ; (5) correct methods ; (6) standard practice and of instruction ; (7) fair ideal ; (8) discipline ; (9) efficiency reward. Second division of instruction : The conference procedure. The subjects selected and questions relating to them were directed along the following line : (1) What is wrong ? (2) who is responsible ? (3) what can be done about it ? Participation chart, first conference. Chart showing participation in conference held to determine remedial measures for problems existing in factory.

TECHNICAL INFORMATION.

U.S.A. Aircraft Year Book, *1939.* (*Inter Avia, No. 686, November 27, 1939 p. 17*).

An average of 36,000 employees were hired by the manufacturers of plane and engines in 1938 ; their export trade gave employment to about 15,000 shop employees, and 44 cents of the average sales dollar was paid to shop labour. The average shop employee in the aroplane plants received an annual wage of $1,550. A comparatively small figure is given as the expenditure by the National Advisory Committee for Aeronautics : $6,002,480 for the five fiscal years 1935-1939 ; in approximately the same period of time, during the calendar years 1934-1938, the aeroplane, aeroplane engine and propeller manufacturers of the United States spent $44,000,000 on research and development work to improve American flying machines. During this same period, exports of American flying equipment amounted to $143,000,000 while commercial sales inside the United States aggregated $107,000,000 ; therefore, commercial domestic and export sales amounted to $250,000,000 or 53.4% of the total, At the beginning of 1939 there were 11,744 non-military aircraft in the United States, 208 gliders, 24,443 aeroplane pilots, 116 licensed glider pilots, 2,374 landing fields of all kinds, 719 of the latter either fully or partially lighted for night flying.

World's Aircraft Production with Special Reference to the U.S.A. (*Inter Avia, No. 687, December 5, 1939, p. 1*).

U.S.A.—The Wall Street Journal estimates the 1940 capacity of the American aviation industry at 674,000,000 dollars. This figure is considered optimistic, seeing that the total November, 1939, sales (a record for the year amounted to less than 20,000,000 dollars. The present back log of the industry amounts to no less than 534,000,000 dollars. Germany.—The German aviation industry has become most reticent and the monthly trade journal *Luftwehr* has ceased publication. The following points should, however, be noted : (1) Even prior to September, 1939, at least 300,000 persons were employed in the German aviation industry ; (2) advertisements for extra staff and published figures concerning increase in capital of a number of firms clearly indicate further expansion ; (3) the possibilities of the Czechoslovak and Polish aircraft industries are bound to become utilised to the fullest extent. Great Britain and France.—Production figures are not available, but it clearly indicates the intention of the Allies (and more especially of France) to look to America as a source of supply. In view of the position of the American industry, and the large demands of the U.S. Army Air Corps,

the Swiss reviewer is doubtful whether any considerable help can be expected from that quarter during 1940.

WELDING, BRAZING.

The Weldability of Heat-resisting Steels. (*The Welding Industry, February, 1940, Vol. VIII, No. 1, p. 15, 5 figs.*).

The possible compositions of heat-resisting steels cover a wide range, but it may be said that an inclusion of chromium is the basis of this type of steel. These steels have an advantage over cast iron and normal structural steels in that they possess the following properties : Resistance to scaling at temperatures up to 1,150°C. ; resistance to sulphurous atmosphere ; greater strength at high temperatures ; and resistance to corrosion by a wide range of corroding agencies. Welded case-hardening boxes complete with drop-in lids fabricated out of heat-resisting steel.

Welding Technique in Aircraft Construction, by Kurt Queitsch. (*Aircraft Engineering, February, 1940, Vol. XII, No. 132, p. 56, 29 figs.*).

Part II.—The welding of fittings. Sheet fairings and tubular structures The wrong way to tack thin sheets. The correct method for tacking thin material. How to tack the joint of a tubular member. Welding jig for a spar fitting, locating pin, guide for bushing tube. Glider control shaft assembly. Construction of a control column. Dornier undercarriage strut, components and welding jig. A Heinkel foot-rest in its welding jig. Undercarriage fitting Tubular strut for an undercarriage cover. Junkers welded joints. Bearing bracket for a hydraulic jack cylinder. The manufacture of highly-stressed spar and bulkhead fittings. Struts. Miscellaneous fittings and parts.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research)

ANNEALING, CASEHARDENING, TEMPERING.

New Furnace for Heat Treating High-speed Steels without Decarburisation or Coating. (*Industrial Power and Fuel Economist, February, 1940, p. 33, 1 fig.*).

The atmosphere is a mixture of balanced carbon oxides, largely diluted with inert nitrogen. It takes advantage of the fact that, at a given temperature, oxygen in equilibrium with carbon is non-oxidising to iron and non-decarburising to steel. The atmosphere protects all types of steels, both high-speed and carbon. It is non-decarburising to all steels, being neutral or slightly carburising as desired. Either a horizontal or vertical muffle design of furnace is available and there are different temperature ranges for treating various high-speed and carbon steels—760° to 1,010°C., and 1,095° to 1,350°C.

Selection and Hardening of Tool Steels for Prevention of Damage, by Howard Scott. (*The Tool Engineer, February, 1940, Vol. VIII, No. 10, p. 13, 10 figs.*).

The major kinds of damage to tools which are likely to occur on hardening are classified as follows : 1.—Damage at furnace temperature : (a) oxidation (scaling) ; (b) decarburisation ; (c) warpage by sagging. 2.—Damage due to quenching operation : (a) cracking ; (b) distortion ; (c) incomplete hardening. Avoidance of surface damage. Selection of quenching liquids. Trouble-free hardening.

BELTS, ROPES.

V-Belts versus Flat Belts, by H. Stuart Jude. (*Power Transmission March, 1940, Vol. IX, No. 98, p. 70*).

In exactly the same way that no one flat belt is equally suitable for all service conditions the choice of flat or V-belts ought to be decided for each separate drive and in full view of all the characteristics concerned. The acid test. Group and individual drives. Points which matter : the quarter-turn layout. Silence is often a desirable feature in a workshop. There are many instances where manual work occupies the greater part of the available floor-space, resulting in the power-driven machines being more or less isolated units. Cost. Maintenance. Installation of V-belts. V-drive design. Trouble-free service. On the whole, the flat belt does not get a square deal, and until the conditions for V and flat types are comparable in every respect one ought not to be airily dismissed as " inferior " to the other.

EMPLOYEES, WORKMEN, APPRENTICES.

Women's Work in War-time. (*Machine-Tool Review, January-February, 1940, Vol. XXVIII, No. 172, p. 5*).

Female operators are drilling and tapping on Herbert all-electric machines ; doing bar work on a senior capstan lathe ; operating automatic chucking

machine; doing high-speed vertical milling; operating a new Britain four-spindle automatic chucking machine; doing light milling on horizontal milling machine; surface grinding; cylindrical grinding; centreless grinding; working as fitters, using air-operated bench vice.

A Study of Temporarily Unemployed Girls at a Junior Instruction Centre, by May Smith and Margaret Leiper. (*Occupational Psychology, April, 1940, Vol. XIV, No. 2, p. 82*).

The aim was to discover whether such a group differed significantly from girls not so circumstanced. The industrial records of the group were therefore compared with those of girls, similar in age and employability, but whose names were drawn at random from Ministry of Labour files. Certain important differences were found between the two groups; those at the Junior Instruction Centre, for example, tended to be less stable—they lost their jobs sooner, they had a larger number of jobs in their first year, and they spent a smaller percentage of their employable time actually in a job. When the girls in the Junior Instruction Centre were given certain psychological tests some other interesting facts emerged, for the tendency to industrial instability appeared to be linked with low intelligence.

An Investigation into the Selection of Apprentices for the Engineering Industry, by F. Holliday. (*Occupational Psychology, April, 1940, Vol. XIV, No. 2, p. 69*).

Some 130 trade and engineering apprentices and shop boys were given intelligence and other psychological tests. Subsequently, full reports on their progress both in technical training and in the works were obtained independently from instructors and the apprentice supervisor. The reports and test results were then compared. Among other interesting facts it was found that success in a battery of specialised tests and success in engineering drawing corresponded fairly closely. So also did success in an ordinary intelligence test and success in engineering mathematics. Again there was remarkably close agreement between the grading of trade and engineering apprentices by the specialised tests and the independent reports of the supervisor, taking into account the apprentices' records in the shops and instructional classes. Other similar facts have emerged, suggesting that the tests could be relied on to indicate quickly and easily what abilities the apprentices would show in their work.

FOUNDRY, MOULDING.

Aluminium Bronze Gravity Die Casting, by A. Street. (*Engineering, February 23, 1940, Vol. CXLIX, No. 3,867, p. 190, 2 figs.*).

The effect of added elements. The addition of about 3% of iron to aluminium bronze refines the grain and prevents self-annealing. The addition of each 1% of iron increases the tensile strength by 2 tons to 2.5 tons per sq. in., and this rate of improvement continues with iron additions up to about 4%. Workers in the aluminium-bronze die-casting foundry, however, sometimes report that very high iron contents increase the difficulty of manufacture. Table V shows the properties of cast aluminium bronzes, containing varying quantities of iron and other elements. Gravity die-casting is the process almost exclusively applied where aluminium bronze is concerned. The mould is generally constructed of ordinary or high-grade cast iron, 3% nickel-steel, or a special alloy cast iron, while the cores and important portions of the die are often made from a heat-resisting alloy steel. The die and cores used to produce an aluminium-bronze shackle for a sports car are shown. The production may average from 30 castings to 40 castings per hour, while with

a bulky component it may be less than 10. The best working temperature of the die is between 250° and 400°C. The mould should last from eight to 15,000 castings, but cores, particularly those which become greatly heated, are likely to require renewal at shorter intervals. Holes of less than ¼ in. diameter are not usually cast on account of the wear which would occur in the slender core pins. Holes which are cast are tapered by at least 0.015 in. per inch of length. On account of the high temperature involved, the casting of threads is practically never attempted. Complexities such as crossing cored holes and undercuts should be avoided as their inclusion would slow up production and reduce the life of the dies. The chief factors affecting the solidity of an aluminium-bronze die-casting concern the designer of the part. By careful attention to design it is nearly always possible to avoid heavy masses of metal and to make the section uniform. Experience is continually being gained in the methods of producing gravity die-castings so as to obtain the maximum solidity. The use of the gravity die-casting process enables most of all the machining operations to be eliminated and it allows rapid deliveries of components to be made at a competitive cost.

GEARING.

Epicyclic Gearing, by F. W. Shaw. (*Machinery, March 7, 1940, Vol. LV, No. 1,430, p. 633, 11 figs.*).

A simple universal formula for determining the speed and gear-train ratios with examples illustrating its application. Some simple trains analysed. Epicyclic gearing in which the train ratio or train value is negative. Speed- and gear-ratio graph. Effect of compounding in bevel-geared trains. Versatility of positive bevel-geared trains. Multiple bevel trains.

Epicyclic Gear Analysis—III, by A. B. White. (*Power Transmission, March, 1940, Vol. IX, No. 98, p. 61, 6 figs.*).

Bevel epicyclic trains. Tooth loads.

KINEMATICS.

Special Types of Breeches Pieces, by W. Cookson. (*Sheet Metal Industries, February, 1940, Vol. XIV, No. 154, p. 166, 4 figs.*).

Pattern for flush-sided breeches piece. Construction of layout. Description of alternative layout. Pattern for flush-sided breeches with parallel ends. Pattern for two-way transitional elbow.

JIGS AND FIXTURES.

Drilling and Indexing Jig with Pitch-correction Device, by R.F. (*Machinery, March 28, 1940, Vol. LV, No. 1,433, p. 732, 3 figs.*).

The jig was designed for drilling mild-steel cylinders, 25 ft. long by 25 in. diameter with a wall thickness of ⅝ in. The specification called for 31 holes in each of the circular rows and 96 in each longitudinal row. It was necessary for the extreme centres to be with 0.03125 in. of the drawing size. Twenty-four holes were drilled and the extreme centres tested, this test disclosing a minus error of 1/64 in. between the first and the twenty-fourth hole. In order to correct this minus error a two-piece eccentric indexing plunger was made, the amount of eccentricity being equal to the minus pitch error in 24 holes. The first, or master, row of holes around the circumference of the cylinder was used for location when drilling the second row, and so on. After the master row of 31 holes had been drilled the cylinder was transferred to a drilling machine with the indexing jig set up and with the indexing plunger

positioned. The method just outlined does not give truly straight lines of holes longitudinally due to the changing vertical axis of the eccentric end of the plunger when rotated.

Flexible Couplings and their Applications. (*Machinery Lloyd, March 23, 1940, Vol. XII, No. 6, p. 17, 12 figs.*).

" Pin type " flexible coupling. The pins and bushes are easily removed and lend themselves to quick replacement. " L type " flexible coupling. The drive is transmitted by leather rings which give flexibility and a reliable means of securing electrical insulation. " C type " flexible coupling. This is primarily a heavy duty coupling and is suitable for all applications where heavy shocks are encountered. " Carrier ring " with spring steel santilevers as used in carrier ring type flexible couplings.

Machine Tool Spindle Analysis, by Thomas Barish. (*Mechanical World and Engineering Record, March 15, 1940, Vol. CVII, No. 2,776, p. 226, 9 figs.*)

Surface grinder with motor directly on spindle. The spindle is long but of liberal diameter. Heavy-duty grinder with motor direct-coupled to short wheel spindle. Curves of bearing and spindle deflections. Deflections of bearings and shaft of two-bearing heavy-duty shaft for a multiple-spindle automatic. Deflections in re-designed spindle, using two bearings in parallel at either end. Test arrangement for comparing rigidity of parts of oscillatory-race grinder. Original work head and deflection curves. Spindle deflection versus centre-bearing space of redesigned work head. Final design and deflection calculations.

MACHINE TOOLS.

The Rawplug Electric Hammer. (*Engineering, March 29, 1940, Vol. CXLIX, No. 3,872, p. 347*).

The hammer will drill holes in hard material up to and including $\frac{3}{8}$ in. in diameter, an indication of the speed of drilling being given by the fact that in such material a hole $\frac{1}{4}$ in. in diameter by 2 in. deep can be drilled in about half a minute. The rotor speed is approximately 4,500 r.p.m., and the current consumption about 170 watts. The constructional details of the hammer are shown. The cylinder is divided transversely by a fibre partition, and each half of it contains a hard steel ball free to move radially. Rotation of the cylinder on its spindle naturally tends to cause both balls to fly outwards from centrifugal force. At one termination of the cam the ball is freed, and thereupon flies out to strike the hammer carrying the tool holder. By a reduction ratio of 1 : 3, the cylinder is moving at about 1,500 r.p.m., and when there two balls about 3,000 blows are given per minute.

MANUFACTURING.

Manufacturing of Cyclone. (*Aircraft Production, April, 1940, Vol. II, No. 4, p. 109, 16 figs.*).

Part I.—Production methods at a leading American aero-engine plant. Experimental department. Foundry and heat-treatment. Cylinder head and barrel.

Production of Small Press Components, by Phillip Gates. (*Machine Shop, March, 1940, p. 32, 8 figs.*).

There are numerous cases where a particular component made as a pressing could have been produced from bar stock on an automatic or capstan lathe

with equal success as far as dimensions are concerned, but a decision to adopt such a method would, of course, only be taken after the prevailing circumstances had been reviewed. The question of quantity may decide matters. The press should not be regarded merely as a machine for the production of articles from sheet material. It can, for example, be exploited on small turned or milled components. Examples: Contract work; types of tool. The question of die layout is of prime importance affecting as it does any following operation such as bending, also the economic production of the component. Interesting examples are shown. Brass stop. Diagram of tools for bending the ends of the clip, joining to U-shape and the final forming. Press tool troubles. Spider before and after drawing.

MATERIAL, MATERIAL TESTING.

Laboratory Tests for Fibre Resistance. (*Neoprene News, No. 8, p. 8, 4 figs.*).

Neoprene replaces rubber. An effective demonstration of the difference in fire resistance between neoprene and rubber is furnished by the behaviour of perforated sheets exposed to a gas flame. When a sheet about $^3/_{16}$ in. thick of a typical fire-resisting neoprene compound is supported horizontally in the middle of a not non-luminous Bunsen flame, which passes through a hole of its own visible diameter in the sheet, nothing occurs beyond a slight charring, round the ed ges of the hole. However long the experiment continues the small area affected does not extend. If, on the other hand, the sheet be made from a rubber compound of similar composition as regards the other ingredients present, the flame quickly ignites the edges of the hole and the fire spreads rapidly until the whole sheet is blazing. The horizontal burning test. The vertical burning test. Measuring the fire resistance of neoprene. Results of this test in diagrammatic form. Physical properties. Relevant figures, showing both the neoprenes and the rubbers to be strong, soft, extensible compounds. Tensile strength (lb. per sq. in.), elongation of break, %, Shore hardness (durometer type A).

Some Technical Notes on Cutting Oils, by Alan Wolf. (*Machine-Tool Review, January-February, 1940, Vol. XXVIII, No. 172, p. 36, 2 figs.*).

"Straight" and "soluble" cutting oils.—Definitions. The testing and analysis of cutting oils. Corrosion tests on cutting emulsions. Syphon drip test for determining the corrosive action of cutting emulsion. Other rusting tests. A typical result of the syphon drip test showing the corrosive effects of different grades of cutting emulsions. Drip versus immersion tests. Emulsifiability of soluble oils. Water emulsibility test at low temperatures. Emulsion stability tests. Emulsion stability, heat and exposure test.

MEASURING METHODS.

Surface Finish, by G. Schlesinger. (*Machinery, March 28, 1940, Vol. LV, No. 1,433, p. 721, 21 figs.*); *I.P.E. Journal, March, 1940, Vol. XIX, No. 3, p. 87, 21 figs.*); (*Engineering, March 29, 1940, Vol. CXLIX, No. 3,872, p. 343, 11 figs.*); (*Machinery Lloyd, April 6, Vol. XII, No. 7, p. 21, 21 figs.*). (*Mechanical World and Engineering Record, March 29, 1940, Vol. CVII, No. 2,778, p. 269, 5 figs.*).

The objects of this research are: (1) To replace the present loose descriptive methods of definining surface finish by a more definite system; (2) to select a suitable unit for measuring surface finish; (3) to suggest symbols for use on drawings; (4) to compare the methods of evaluating surface finish. Profilograph records of surfaces produced by various machining processes. Diagrammatic representations of the turning, grinding, and honing processes and of the surfaces produced thereby. A typical honing tool for the accurate

finishing of bores. Diagrams illustrating the path of the abrasive stick during the honing operation. The particles of abrasive do not cut uniform helices nor follow previous paths, and the stone frequently cleans itself. A close-up view of a mechanical lapping machine set-up for finishing valve stems. Measuring unit and symbols on drawings. The Busch microscope which permits of the comparison of surface finishes. The Higgins (Klemm) comparoscope which is arranged for automatic focusing. The Busch metaphot whereby surface finish may be observed or recorded photographically. Photomicrographs under bright-field and dark-field illumination. The Zeiss-Schmaltz microscope which enables surface roughness to be measured. The Abbott profilometer in use in the Research Department. The contorograph of Harry Shaw, whereby the surface profiles are recorded on the needle and lever principle. Contorograph records of ground and scraped surfaces. Co-operation with the National Physical Laboratory.

MECHANICS, MATHEMATICS.

The Distribution of Load on the Threads of Screws, by J. N. Goodier. (*Journal of Applied Mechanics, March, 1940, Vol. VII, No. 1, p. A-10, 15 figs.*).

The distribution of load on the threads of screws and the types of deformation affecting it have been investigated by means of extensometer measurements made on the outside of the nut. It is shown that the distribution is governed by: (a) stretch and compression in bolt and nut, respectively, which are primarily responsible for concentration at the base; and (b) by bending of the thread, circumferential stretch (at the base), and contraction (near the free end) of the nut wall, which have comparable effects in reducing the concentration.

Metal-cutting Power Calculations, by Paul H. Miller. (*The Machinist, March 2, 1940, Vol. LXXXIV, No. 2, p. 23*).

A simple formula for obtaining the approximate power requirements for machining a variety of metals. The investigation covered the machining of a variety of S.A.E. steels, several grades of plain and alloy cast irons, and a few non-ferrous metals and alloys. Table I contains power constants for ferrous metals and alloys. The table is based on *material* (S.A.E. steels, 1,010 to 6,195, plain cast iron, alloy cast iron, malleable iron, cast steel)—Brinell hardness numbers—power constant for average jobs. Table II contains constants for non-ferrous metals and alloys. The materials: brass, bronze, aluminium, Monel (rolled), zinc alloy (die cast) are connected with their constants. A series of actual tests are made to check the formula. Table III contains the suggested form for calculating machine horsepower.

PLASTIC MATERIAL.

Combining Plastics and Metals, by J. Earl Simonds. (*British Plastics and Moulded Products Trader, March, 1940, Vol. II, No. 130, p. 444, 20 figs.*).

Progressive improvement in the methods employed in recent years in "marrying" metals to plastics or vice versa. These newer methods are: (1) crimping method; (2) metaplast plating; (3) Chilton process; (4) speed nut method; (5) press on method; (6) Probar metalliques; (7) wrap-around method. The *crimping method*: Cross-section of knob as moulded. Cross-section of knob with top inlay and ram assembly crimped in place. Actual knob, showing old and new methods. *The method of attaching thermo-plastic parts* to wood, metal, etc. *The Probar method*: The projecting points can be seen as small dots round the periphery of the discs. Handles and knobs according to the *wrap-around* method. The *Chilton process* requires two metal parts—one being the inlay proper and the other is known as the base metal.

Sketch of Chilton inlay. The *metaplast* process gives positive adhesion between the metal plate and the plastic material, because of a special bond coating treatment given to the plastic material before plating. The familiar directional signal light is a splendid example of utilising the *speed nut* method for securing metal parts to plastic parts. To use the *press-on* method the plastic part is moulded with a recess into which is pressed a composite disc. The groove or recess in the plastic part is usually dimensioned so as to cause a rather tight fit for the composite disc—usually some adhesive is placed around the groove or recess before the composite disc is pressed into place.

SMALL TOOLS.

Machining with Single Point Tools, by M. Kronenberg. (*The Tool Engineer, U.S.A. February, 1940, Vol. VIII, No. 10, p. 17, 3 figs.*).

Cutting speed and work diameter. Diagram for relationship between diameter of work (D), R.P.M. and cutting speed (V). Angles for high speed and steel tools. Cutting force as a function of chip cross sectional area. Cutting pressure as a function of depth of cut and feed/rev. values for steel and cast iron. Values for other materials. Cutting force and work-piece. Multiplication factors for calculation of cutting force. The " LDFA " diagram : Giving relationship between length of work (L), diameter of work (D), cutting force (F), and chip cross-sectional area (A). Productivity diagram for selecting the most effective combination of cutting variables. The very important fact will be seen, that two different relationships exist between chip cross-sectional area A and cutting speed V. Basic principles which govern machining by single-point tools can be derived from this fact.

Cutting Tools—Part II, by G. Schlesinger. (*The Machine Shop Magazine, February, 1940, p. 44, 3 figs.*) ; **Part III,** *March, 1940, p. 47, 7 figs.*).

Part II.—The manufacture of tipped tools by brazing. Wet grinding is recommended and should be carried out with extreme care. Cutting fluids increase the life of the tool considerably in all cases, especially in cutting steels of all kinds. German and American standards of relation between materials and cutting angles. Rules for handling of cemented carbide tipped tools. Shape of chip. Grinding cemented carbide tipped tools. Diamond wheels. Finishing speeds. Part III.—Diamond boring tools. Methods of securing diamond tools in tool bars. Diamonds with multiple cutting edges and ball seating. Good working conditions for diamond tools. Working tolerances of .002 mm. (0.00008 in.) may be maintained with a very fine surface finish surpassing that of a fine-grinding action. Reheating cobalt tungsten tools. The simplest but most widely used tool with two simultaneously cutting edges is the *twist drill.* Correct grinding of the point edges and centre is decisive : economic effect 11 : 1 with original and revised grinding angles ; speed and power consumption ; speed and length drilled. Stag Major drill for manganese steel. *Milling cutters* : Cutting conditions ; testing apparatus of cutter action ; oscillographs of cutter action. Discussion of the " variables " for the machining operations : (1) The workpiece ; (2) the tool ; (3) the process of machining ; (4) the chip formation ; (5) the machine tool ; (6) the coolant.

TECHNICAL EDUCATION.

Government Training Centres. (*Machine-Tool Review, January-February, 1940, Vol. XXVIII, No. 172, p. 14, 8 figs.*).

Machine-tool reconditioning. Instrument making. Capstan lathe work. Instruction in draughtsmanship. Instruction in cylindrical grinding. A

corner of the Inspection Room at the Leicester Training Centre. Press tools made by trainees at the Leicester Government Training Centre.

TECHNICAL INFORMATION.

Statistics and Engineering Practice, by B. P. Dudding and W. J. Jennett. (*Machinery, March 21, 1940, Vol. LV, No. 1,432, p. 696, 11 figs.*).

Elementary review of methods, based on statistical theorems, which can be used to help engineers handling data influenced by a multiplicity of factors, to answer a question which arises continually in industrial practice. Frequency distribution. Gaussian distribution. Examples : Errors in adjustment of thermostats ; breaking load of strips of cotton fabric ; breaking strain of glass tubing ; sensitivity of photo-electric cells. Control chart for means of samples. Chart of variability. Chart for proportion " defective." Use of binomial distribution, use of mean and standard deviation.

WELDING, BRAZING.

Precision Welding of Small Parts by Spot Projection Methods, by J. L. Miller. (*The Welding Industry, March, 1940, Vol. VIII, No. 2, p. 53, 21 figs.*).

Spot welding is resistance welding : (1) The weld is made at a spot by heat and pressure ; (2) the heat comes from the electrical resistance of the metals being welded. Spot size and current density. Table I contains : Sheet thickness, diameter of weld, ratio weld dia. 2 × t., breaking load in lbs. Table II contains : Sheet thickness, tip diameter inches, $\frac{\text{weld size}}{2 \times t}$ Projection welding reduces the sources of variation and brings the welding process nearer to the production engineer's ideal, a completely controlled process. In projection welding as many as 10 welds may be made at one stroke. Spot weld development : oscillograph. Curve showing change of weld diameter with welding time. The development of a projection weld is in marked contrast to that of a spot weld. Projection welding offers the following advantages : (1) Increased consistency of results ; (2) increased output per machine or per sq. yd. of floor space, occupied as several welds may be made at once ; (3) longer working life of electrodes without attention ; (4) welds may be close together ; (5) the finished appearance is improved. It is necessary, to ensure contact, that there should be a certain amount of pressure on the projections before the welding current is applied. Current and time in spot and projection welding. Electrodes and welding fixtures. Welding machines. A good many welding fixtures are shown—e.g., fixture for welding three brackets on lamp body, fixture for welding tubes to a bracket, giving bracket to lamp body, dipper unit bracket.

Arc Welding on the Railways, by a Railway Engineer. (*The Welding Industry, March, 1940, Vol. VIII, No. 2, p. 38, 7 figs.*).

The reasons for the adoption of welding in the manufacture and repair of locomotives, carriages and wagons have been stated by Mr. W. A. Stanier, Chief Mechanical Engineer of the London, Midland and Scottish Railway in the following manner : " (1) It is, in many cases, the means of producing a cheaper article than can be obtained by forgings, castings or riveted construction ; (2) it is almost always capable of affording a lighter article than the older methods of production whilst retaining adequate strength ; (3) it enables repairs and reconditioning to be carried out to worn parts, which could otherwise have to be completely renewed, or impaired by the less satisfactory method of patching or bushing. Railway carriage underframes. Solebar units. Headstock units. Bolster units. Middle unit. Strength welding of units in position in the underframe. Twelve-ton wagon underframe con-

structed by welding. Welded underframe for covered goods wagon. Welding procedure. A four-wheeled all-welded 20-ton capacity flat wagon.

Some Practical Examples of Repairs by Electric Welding, by C. W. Brett. (*Electric Welding, February, 1940, Vol. IX, No. 50, p. 59, 6 figs.*).

One notable example concerned a large punching and shearing machine. The damaged casting weighed 3½ tons and measured 11 ft. in length and 8½ ft. in height. The extent of the cracks in the frame can be seen clearly. After welding repairs the strength of the casting was estimated to be 50% greater than when it was new. An unusual type of a crankshaft belonging to a steam car. A fracture developed across one of the webs. It was a hardened shaft, and the journals being so close together made lining up difficult. The shaft after repair by Barimar. As the journals and crankpins were worn, they were reground and the latest report is that this interesting car is running most satisfactorily. One thousand ton hydraulic press head split from top to bottom. Welding was carried out in the site. After several weeks work the repair was completed and is one of the largest welding repairs in this country.

Spot Welding of Light Alloys. (*The Engineer, February 23, 1940, Vol. CLXIX, No. 4,389, p. 189, 2 figs.*).

The welding of light alloys is a much more difficult and delicate task than the welding of steels. In general, they are good conductors of heat and electricity, their melting point is low and close above the temperature at which they soften and can be welded. At normal temperatures most of them are easily corroded and more so when they are heated. With some light alloys, the structure alters when they are raised above a certain temperature and special heat-treatment is necessary to restore them to the normal condition. After long exposure to air, the surface of light alloys becomes coated with a thin film of oxide, very hard and very adherent. This presents the disadvantage from welding point of view, that the film has a very variable resistance value. To weld aluminium alloys at the high electrode pressures desirable, considerable instantaneous power is required. A method claimed to be relatively cheap and convenient is to store the energy in an inductance or condenser as used by Philips Industrial, Ltd. Both these systems can be made to give a high current discharge in hundredths or thousandths of a second, whilst the preliminary energising of the systems can take place a hundred times more slowly giving an insignificant peak load on the mains. Diagrams of : Principle of welding machine with condenser storage ; principle of welding machine with inductive storage. Conclusions : (1) Light alloys must be welded with high electrode pressures ; (2) the quantity of heat supplied to the weld must be very carefully controlled and this can only be done satisfactorily with an electronic interrupter or by an accurate and efficient storage device ; (3) since the charge of storage condenser machines is limited automatically to a given value according to the peak voltage of the supply, they are very convenient in operation ; (4) welding at very high speeds, i.e., less than a hundredth of a second offers no advantage and can give rise to metal projections between the workpieces ; (5) the condenser method has the advantage that the discharge time can be controlled without the use of a resistance and thus without lessening the efficiency.

Welding Technique in Aircraft Construction, by Kurt Queitsch. (*Aircraft Engineering, March, 1940, Vol. XII, No. 133, p. 87, 11 figs.*).

Some practical hints on the welding of engine mountings. The majority of aeroplanes have welded engine mountings. As this component is subjected to very high loads, only the conscientious welding of experienced operators can guarantee a safe job. Same examples give a general idea of the welding

of such components. Engine mounting V-strut (Dornier). Engine bearer welded from pressed steel parts. A lower member of the Dornier Do. 18 engine mounting. A radial-engine mounting (Dornier) with its welding jig. Bending a steel ring with wooden template. Engine mounting of the Heinkel He. 46. Welding jig for the engine mounting.

WELFARE, SAFETY, ACCIDENTS.

Canteen Feeding in War-time. (*Industrial Welfare, March, 1940, Vol. XXII, No. 256, p. 86*).

Value of communal feeding. Novel dishes. Foods needed for health. The protective foods—those which contain small quantities of certain minerals and vitamens which safeguard the body against disease and infection : calcium, iron, iodine, vitamins A and D, vitamin B. Methods of cooking. Substitutes for meat. Fish and vegetarian dishes. The sweet. Snacks. War-time recipes.

Research Department: Production Engineering Abstracts

(*Edited by the Director of Research*)

COMBUSTION FURNACES.

The Influence of Controlled Atmospheres in the Heat Treatment of Steel, by A. Fisher. (*Machinery, April 11, 1940, Vol. 56, No. 1435, p. 51, 4 figs.*).

The control of combustion—town gas. Table I—gas reactions with steel. Table II—reaction equations for various gases with steel. Table III—constitution of typical town gas. Requirements for neutralisation. The constitution of the products of combustion. Reaction tendencies with different air-to-gas ratios. Relation of oxidising and decarburising tendencies to air-gas ratio, with town gas as fuel. Diagrammatic representation of atmosphere flow in gas furnaces connected to stacks. Door leakage effect considerable, door leakage effect negligible. Combustion products of typical producer gas. The control of combustion-producer gas. Typical analysis of producer gas.

GEARING.

Design of High-speed Gears, by K. Knibbe. (*J. Aeron. Sci., U.S.A., Vol. 7, No. 2, December, 1939, p. 68*).

Designing a successful reduction gear to handle power outputs of modern aircraft engines in excess of 1,000 h.p. has proved to be a very difficult problem. In the average high speed application, the conventional tooth strength is not the controlling factor. The final step is in the so-called " wear factor." This is a function of the surface stresses on the tooth flank. The purpose of the present paper is to supplement this last and most important phase of the gear problem. The stress on the tooth surface depends upon the radii of curvature as worked out by Hertz. Upon this is based a method to determine the maximum energy that can be safely transmitted from one gear to another during one revolution. This quantity of energy, divided by the square of the diameter of the pinion and a constant is called " power-function of the gear " and is a dimensionless quantity. It can be easily determined by a tooth form layout to any enlarged scale. This power function is calculated with various pressure angles, addenda, and gear ratios. The above has been applied to actual gears built, and it was found that whenever the power function was increased, the wear qualities also improved. There was no opportunity to test the theory quantitatively.

JIGS AND FIXTURES.

Design of Universal Drill Jigs, by J. I. K. (*Machinery, April 4, 1940, Vol. 56, No. 1434, p. 31, 6 figs.*).

A detailed review of the factors to be considered in designing drill jigs that combine economy with operating efficiency. Concentric external location from top plate. Concentric external location from adapter. Plane of work. Chip disposal. Locater lead. Interchangeability. Radial location in universal jigs. Radial location from the adapter. Coolant reservoir. Tools for making top plates. Simple drill plate. Dividing-head fixture.

MACHINE ELEMENTS.

Engine Bearings—from Design to Maintenance, by A. B. Willi. (*J.S.A.E., U.S.A., Vol. 45, No. 6. December, 1939, p. 513*).

There are six major causes of bearing failures namely : faulty design, purchase based on incomplete specifications, mis-use and abuse in operation, faulty installation, unsuitable lubricants, and mechanical faults in the bearings themselves. Although there are four general types of bearing materials in common use for main and rod bearings (tin-base babbitts, high-lead babbitts, cadmium alloys, and copper-lead mixtures), it is shown that not one of them is a universal bearing material but each has its own particular usefulness. These fields are defined in terms of maximum unit pressure, oil reservoir temperature, and crankshaft hardness. Design factors which react against indicated satisfactory performance are discussed, including strength and stiffness of the bearing structure, restrictions in feed grooves, oil clearance, etc. Design standards relating to these points are established. Identification of failure due to mis-use is illustrated by means of typical examples.

MACHINE TOOLS, MACHINING.

Must a Rigid Machine Tool be Heavy? by Franz Koenigsberger. (*Machinery, April 18, 1940, Vol. 56, No. 1436, p. 85, 4 figs.*).

Diagram illustrating the forces resulting from the rotation of an unbalanced member in a lathe head-stock. Diagram of a lathe used to determine to what extent rigidity depends on weight. Curves showing the periodic variation of the bearing forces and the torsional moment. Diagram illustrating the principle of the static method of balancing a grinding wheel assembly. Conclusions : The weight of the grinding machine is not a decisive factor affecting its stability and rigidity, and consequently, the quality of the work which it produces. For certain purposes, however, weight in a component, or a machine as a whole is essential. While great weight in a machine is not essential to its smooth running and freedom from vibration, it cannot be stated as a general rule that light-weight steel construction although very advantageous in many cases, is always to be preferred. Each design must be considered individually.

Modern Precision Grinding Methods, by R. Brule. (*Airc. Eng., February, 1940, p. 49*; transalated from *Rev. Techn. Hispano Suiza, No. 5, July, 1939*).

For production of components requiring extreme precision in manufacture, grinding wheels are replacing other tools. The nature of the agglomerant, the abrasive, shape of the workpiece and speed of revolution are considered in turn. Particular attention is paid to methods of supporting the work piece for various grinding cuts, including the case of shaped grinders. Details of thread cutting by these tools are given, together with a method by which the accuracy may be checked while the operation is in progress. The application of grinding to the elastic water-tight joint of the cylinders of Hispano Suiza liquid-cooled engines is described.

Coal Crusher Hammers, Hardfaced with Stellite. (*Industrial Gases, January, March, 1940, Vol. 21, No. 1, p. 40, 4 figs.*).

The Flextooth crushers built by British-Jeffrey-Diamond, Ltd., Wakefield, work on the rotary principle. The rotor illustrated carries four rows of heavy cast steel hammers, loosely pivoted so that the working end swings outward by centrifugal force. Drawing to show action of hammers. Stellite is applied to the face and sides of the hammers. A group of hammers in various stages of building up.

MANUFACTURING.

Manufacturing the Cyclone. (*Aircraft Production, May, 1940, Vol. II, No. 5, p. 151, 27 figs.*).

Part II : Production of pistons, connecting rods, crankcases, and propeller shafts ; assembly ; a new experimental test house. Diamond boring the crank and gudgeon pin holes on a specially designed Wadell diamond boring machine to a finish of 2.5 to three micro-inches. Fixture for chrome plating the knuckle pin holes. Individual anodes are accurately centred in each hole. Set-up of two Toledo scales for weighing each end of the master rod. Very close limits are maintained on this part. Grinding the internal splines on the reduction gear assures accurate fit at assembly. Accurate dynamic balancing is essential for smooth performance. Accidents are prevented and man power economised by using a pneumatic loading device for placing heavy crankcase sections under the drill head. Each part in its proper place, a dismantled engine is transported on rolling tables to the inspection rooms for complete inspection after the "green" run.

Machining Methods for Aero-engines, by Guiseppe Carro Cao. (*Aircraft Engineering, April, 1940, Vol. XII, No. 134, p. 117, 36 figs.*).

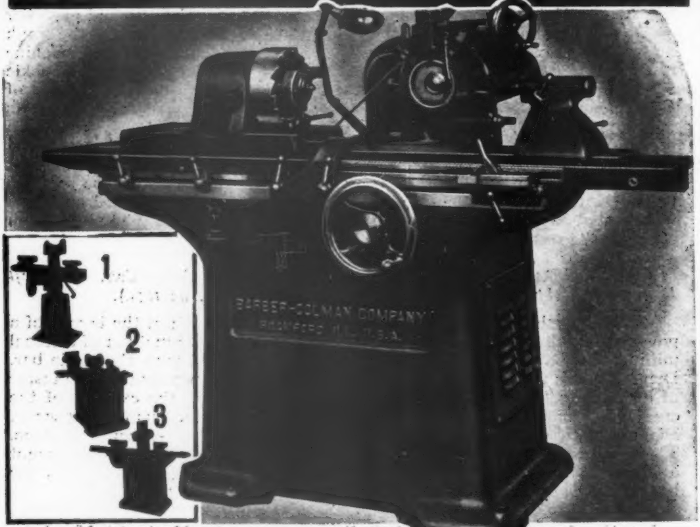
Working cycle for a radial-engine crankcase. As sketch of the layout of a power pack universal miller. Diagrammatic sketch of the method of internal milling, showing the way in which the cutter is linked with the guide bar. Diagrammatic section of a special boring machine for working on the inside of a crankcase. Method of guiding the tool for milling the exterior of the crankcase. Diagrammatic sketch of the machine used for this type of work. Diagrammatic representation of the three-headed cylinder-opening machine. The workhead used for facing the cylinder-spigot holes. The cylinder-spigot hole boring head of the Piaggio crankcase machine. A general view of the blower casing machine. Diagrammatic views of the tool heads.

Cartridge Case Technique, by S. D. Brootzkoos. (*The Machinist, March 30, 1940, Vol. 84, No. 6, p. 46, 5 figs.*).

Cartridges are made of "cartridge brass" on account of its high ultimate tensile strength (about 37,000 lb. sq. in.) and large percentage of elongation (54-57), containing 68 to 71% copper and 29 to 32% zinc. Cartridges are formed from flat rolled strip or ribbon stock. During the cupping and ironing operations, the walls of the tube are thinned, but the bottom remains at approximately the original thickness of the metal. Socalled "drawing" operations are better referred to as "ironing" since the metal is both compressed and stretched. In figuring the wall thickness of tapered and pecked-in shells, it is assumed that the cross-sectional area of the cartridge and that of the original straight line are equal. Artillery cartridge cases are indented to get enough metal in the head for the primer pocket. Pickling removes spots. The speed of production is governed by the ironing speed which the cartridge brass can withstand most advantageously. This speed is about 35 ft. per sec. for cups and shallow shells, about 30 ft. per sec. for medium deep shells and about 25 ft. per sec. for deep shells.

Forging and Stamping of Aeroplane Propeller Blades from Magnesium Alloys of High Strength, by S. M. Voronov and L. Y. Shpolyanski. (*Avia promyshlennost, U.S.S.R., No. 2, 1939, pp. 24*).

Magnesium alloys containing 4.5 to 5% Al, 0.5 to 0.6% Zn and 0.3 to 0.5% Mn are much less easily forged than alloys of the type Dow F. The maximum deformation occurring during forging should not be greater than 20 to 25% to prevent destruction of the material. The alloy has a narrower temperature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BARBER-COLMAN COMPANY

interval of forging than alloys of the Dow-type containing 4 to 4.5% Al. The recommended temperature interval 330 to 350°. The stamped blades of the Al-Zn-Mn alloy should be heat treated by either of the following methods : (i) heating at 350 to 400° for six to twelve hours followed by air cooling ; (ii) heating at 420° for two hours followed by twelve hour ageing at 200°.

Time and Tools, by J. R. Longstreet, and W. K. Bailey. (*The Machinist, April 13, 1940, Vol. 84, No. 8, p. 79, 6 figs.*).

Two things mark a good turret lathe operator. He runs his machine at the correct speed and feed ; he knows how to grind and set cutters for a given job. Total production time for any job is made up of four elements : (1) Setting-up time ; (2) work-handling time ; (3) machine handling time ; (4) actual cutting time. Set-up time work-handling time and machine-handling time may be just as important as the actual cutting time. The illustrations show universal tooling equipment for a permanent set-up for bar-work including such standard tools as single and multiple cutter turners, a combination facer and turner, die and tap holders, and collets. These are quickly adjustable for a variety of work. Pilot bars, slide tools, various boring bars and cutter holders, as well as standard flanged tool holders, make up the permanent set-up of turret lathe tools for chucking work. Set-up for a simple gear blank involves the use of both multiple and combined cuts. Where the number of pieces is small the job would be tooled more simply. *What not to do* : (1) don't block off stations on the square turret ; (2) don't clamp the saddle of a ram-type machine in such a position that all of the stations cannot be indexed ; (3) don't take any tooling set-up for granted. Study the work and see how the set-up can be improved.

Superpressed Plywood, Bonded with Thermosetting Synthetic-resin Adhesives, by R. K. Bernhard, T. D. Perry, and E. G. Stern. (*Mechanical Engineering, Vol. 62, No. 3, U.S.A., March, 1940, p. 189*).

A series of tests has been carried out to determine the most effective means for manufacturing superpressed plywood using common species of wood and a synthetic resin of the phenol-formaldehyde type. This type was selected on account of its proved durability under many conditions. The effects of the following major variables were studied : Thickness of veneer layers $\frac{1}{8}$ to $^1/_{48}$ in.; common species of wood such as birch, yellow poplar and red gum ; increasing pressures 200-1,500 lb./sq. in. ; number of layers of resin film, one to three ; number of cross-layers, alternate, every fifth and every tenth. The results showed that : (1) Veneer thickness affects strength of superpressed plywood considerably ; (2) birch plywood is much stronger than poplar or gum plywood when manufactured under a pressure of 500 lb./sq. in. ; (3) poplar and birch superpressed plywood have similar high strength values when manufactured at about 1,500 lb./sq. in. The strength increment for the same materials varies between 66 and 127% for plywood made under 200 and 1,500 lb./sq. in., respectively ; (4) the amount of synthetic resin influences the strength of the bond ; (5) the arrangement of cross layers affects the strength data to such an extent that this factor should be considered in designing for specific purposes ; (6) the strength of superpressed plywood increases in direct proportion to its density ; (7) the strength of superpressed plywood may be adapted to its proposed function, because its strength can be determined with a fair degree of accuracy.

Traction Production. (*Automobile Engineer, March, 1940, Vol. 30, No. 395, p. 73, 16 figs.*).

A survey of the methods employed at the works of David Brown Tractors, Ltd., at Meltham. Machine shop for detail machining. Layout of main shop, sub-assemblies, final assembly and test plant. Engine and rear axle production.

MATERIALS, MATERIAL TESTING.

Low-lead-silver Alloys for Bearings, by R. W. Dayton. (*Metals and Alloys, Vol. 10, 1939, p. 306-10, 324*).

Alloys containing more than 3.5% lead are very resistant to seizure. A corrosion test on specimens rotating in aerated oil containing 1% of oleic acid at 160° showed complete resistance and an increased seizure-resistance of the specimens. Addition of lead is shown to improve the mechanical properties of silver. Photomicrographs of cast and annealed alloys are given ; intergranular cracking is observed in the latter when lead is excessive (4.68%). Electrodeposition of the Pb-Ag alloy on to the steel backing (from a silver cyanide bath containing lead acetate) is very satisfactory. Preliminary bearing tests made on such plated specimens gave very promising results. The application of bearing alloys with 3 to 4% lead in aeroplane engines is indicated.

Strength Properties of Light Metal Screws, by F. Bollenrath, H. Cornelius, and W. Siedenburg. (*Z.V.D.I., Germany, Vol. 83, No. 44, November 4, 1939, p. 1,169*).

Light metal screws, which give considerable weight economy by comparison with steel screws, also assist in reducing corrosion and thermal stresses when used in assembling light metal parts. So far they have hardly been used at all since insufficient data has been available regarding their properties. A comparative investigation has, therefore, been made of the strength properties of light metal and steel screws under static and alternating stress and of their behaviour on tightening and loosening. The light metal screws, of ordinary commercial sizes, were made from a ductile alloy of the Al-Cu-Mg class and from an alloy of the same class with addition of lead, comparison being made with unalloyed steel screws of equal yield ratio. The strength tests comprised determination of tensile strength, fatigue bending strength and fatigue tension strength (no load reversal), full data for which are given. Results showed that chromium plating and electrolytic oxidation are not advisable, but that light metal screws are practically equivalent to the corresponding steel screws. For fatigue stressing, however, a lower initial stress should be chosen.

Tentative German Standards on Testing of Materials. (*Deutscher Normenausschuss, Maschinenbau, December, 1939, Vol. 18, No. 23/24, p. 608 ; Bulletin of the British Non-ferrous Metals Research Association, No. 128, February, 1940, p. 49*).

These first drafts of standards have been prepared by the " Deutscher Verband für Materialprüfungen der Technik " and are published to elicit comment. They are concerned with methods of carrying out tests, namely : drifting and flattening tests on tubes (DIN Vornorm DVM 135 and 136, respectively), bending fatigue tests on flat light-metal specimens (DIN Vornorm DVM 142) and Rockwell hardness tests (DIN Vornorm DVM 103). For the fatigue tests one specimen at least must have withstood 50,000,000 cycles ; stipulations as to the preparation of the specimen are made.

MEASURING METHODS.

The New Dynamic Balancing Machine. (*Mechanical World, April 19, 1940, Vol. CVII, No. 2781, p. 339, 2 figs.*).

Measurement of force, moment and angularity by a controlled out-of-balance weight. General view of the machine. Diagrammatic arrangement of the machine elements. When equilibrium has been reached by correct adjustment of the compensating system, the amount and angle of compensating are indicated by optical and mechanical measuring devices. Unbalance is measured by unbalance, i.e. by a force of the same nature. Spring or other mechanical elements are eliminated from the measuring device.

Plastic Flow in Metals, by H. W. Swift. (*Metal Industry, February 2, 1940. p. 127*).

The various factors involved in the phenomenon of plastic flow and the present state of knowledge on the subject are discussed. Conditions which cause elastic breakdown, plastic flow, and fracture, are mentioned, and the importance of treating these three phenomena as entirely distinct and independent, is stressed. The relationship between stress and strain under plastic conditions is discussed, and also the phenomenon of strain hardening. Note is made of the fact that plastic strain is a function of time, as well as a function of stress, and is also dependent on the previous strain history of the material. The problem of correlating the stress and strain circle diagram under various conditions of combined stress is considered.

RESEARCH.

The National Physical Laboratory—Report for the Year 1939.

The extraordinary amount of scientific work of the laboratory will be recognized by a short review of the various subjects treated. *A* : *Physics Department.* I : Heat and general physics, Specific heat of very pure iron, Physical constants of steels and light alloys, Thereal conductivity, Evaporation of water from saturated surfaces, Thermophysical properties of refrigerants, International temperature scale, Consultative committee on thermometry, Measurements on high-temperature liquids. II : Radiology, X-ray and gamma-ray dosage, Scattering of X-rays, X-ray studies of the fatigue failure of metals, Structure and mechanical properties of metals, Internal strain in metals, Single metal crystals, Tooth structure, Surface corrosion, Test work. III : Sound, Sound measurements, Noise meter, Noise investigations, " Singing " propellers, Air-raid warning devices, Accoustics of buildings, Sound transmission through walls, Sound transmission through floors, Building structures, Sound absorption, Test work. IV : Optics, Theory of lenses, Radiation measurements, Haemoglobinometer standardisation, Surface finish of metals, Refractometry, Interferometry, Photographic lenses. *B* : *Electricity Department.* I : Electrical standards and measurements. Electrical standards, Precision electrical measurements, Dielectrics, Magnetic measurements. II : Electrotechnics, High-voltage research, Surge impedance of earth connections, Insulators, Dielectrics, Electricity meters, Testing of high-voltage circuit breakers. III : Photometry, maintenance of the photometric standards, Special investigations connected with air raid precautions lighting restrictions, Illumination research, Test work. *C* : *Radio Department.* Propagation of ultra-short waves, Production of ultra-short-wave oscillations, Radio direction-finding, Study of the ionosphere, Measurement of field strength, Measurement of current and voltage at radio frequencies. *D* : *Metrology Department.* Surveying tapes, Refractive index of air, Hyperfine structure of wavelength standards, Gauge testing, Gear and hob testing, Volumetric glassware, Hydrometers, Balances and weights, Barometers, Rating of watches and chronometers, Vibration clocks, Taximeter testing, Fretting corrosion. *E* : *Engineering Department.* I : Materials of construction, Deformation and fracture of metals. Strength of metals under combined bending and torsional fatigue stresses, Fatigue resistance of wires, Materials at high temperatures, Pipe flanges and bolted connections, Gas cylinders, Fatigue and impact resistance of welded joints, Stiffened sheet metal construction. II : Lubrication research. III : Motor-cycle silencing. IV : Road research. V : Test work and minor investigations. *F* : *Department of Metallurgy and Metallurgical Chemistry.* Investigations by means of X-rays, Iron and its alloys, Aluminium alloys, Magnesium alloys, Materials at high temperatures of transformation of steels, Intercrystalline cracking, Refractory materials, porcelain, and glass, Analysis of ancient metals, Analytical methods.

G : *Aerodynamics Department*. Aircraft performance, Stability and control, Fluid flow, Airscrew research, Flutter and buffeting, Generation of swirl in a long pipe. *H* : *The William Froude Laboratory*. Resistance, propulsion, and pitching of ships in rough water, Screw propeller research, Frictional resistance and wake, Manoeuvring of ships, Calculation of the wave resistance of three dimensional forms, Coaster research, Research of ship bows.

SHOP, SHOP MANAGEMENT.

Economies in Tool Control, by F. L. Meyenberg. (*Machinery, April 25, 1940, Vol. 56, No. 1437, p. 118*).

The basic principles of an organisation for tool control which is accurate enough to give satisfactory results, and sufficiently simple to be used in practice. Classification of tools in machine shops into two groups, namely, tools for the individual workman, and general tools. The demand for tools from the shops. Procuring the tools. Calculation of tool costs. Three problems arise concerning supply of tools from the stores, return to the stores of tools no longer being used in the shops, and the repairing of tools. Two questions should be decided before the design of new tools, such as formed cutters, broaches, dies, and punches, is commenced. What is the number of work pieces which will probably be produced within a certain period of time? What degree of accuracy is required by the work pieces? The storage of tools should follow the same rules as the storage of material generally.

Laying out Duct Work from Blue Prints, by W. Cookson. (*Sheet Metal Industries, April, 1940, Vol. 14, No. 156, p. 430, 4 figs.*).

One of the difficulties encountered in laying-out duct work from blue prints is that certain views, which are considered essential for pattern-drafting purposes, are usually not shown by the draughtsman. The new lay-out system of development avoids these difficulties, as the elevation or end view of the job as shown on the working drawing can be used as a basis for obtaining the pattern true lengths. The whole procedure is thus simplified. *Example* : Fan outlet connecting piece. Obtaining the transformer pattern. Twisted transformer with top inclined to a square base.

SMALL TOOLS.

Inserted Tooth Milling Cutters, by F. H. (*Mechanical World, April 19, 1940, Vol. CVII, No. 2781, p. 342, 9 figs.*).

A review of present-day fixing methods. The illustrations show type of fastening used for large facing mills, method of locking by taper pins, individual wedging for cutter face mill, wedge-bush fastening, wedge-bush for lock peg cutters, simple fixing with serrations for readjustment, flatted pin holding blade which is serrated for readjustment, zed-lock wedge preventing lateral slip of serrated blade.

STANDARDISATION.

Revision of British Standards for British Association (B.A.) Screw Threads, by C. le Maistre. (*Machinery, April 11, 1940, Vol. 56, No. 1435, p. 67*).

Grade of fit. Effective diameter tolerances Tolerances on major and minor diameters. Gauges. For external threads. For internal threads

SURFACE TREATMENT.

The Seizure of Surfaces, by T. U. Matthew. (*Mechanical World, April 26, 1940, Vol. 107, No. 2782, p. 364, 4 figs.*).

Wear phenomena correlated with test properties by high-speed photographic technique. With a view to determining the friction forces operating between

various wearing surfaces an apparatus was built, and carefully polished specimens of various steels, and of copper, brass aluminium and lead were run together in contact at different speeds and loads. By coupling the element with a cathode-ray oscillograph through a Wheatstone bridge, and amplifier circuit, it was possible to follow every change in the friction force between the two wear specimens visually on the oscillograph screen. Record obtained from a test on a polished mild steel surface. Lubrication with oils which prevent metallic contact during shock loading, the use of porous and other self-lubricating materials, or the formation of a thin graphite layer on the metal surfaces are, therefore, the most practical methods of reducing friction and wear at the present moment, in cases where these methods are applicable.

The Surfacing of Metals by the Oxy-Acetylene Process. (*Industrial Gases, January-March, 1940, Vol. 21, No. 1, p. 4, 14 figs.*).

A metal may be surfaced with metal similar to the original or it may be given a surface harder than the original. In the same way, parts may be surfaced with metals which provide greater resistance to corrosion or heat-scaling than the base metal. Metals for surfacing fall roughly into three groups : High carbon and alloy steels, cast iron and non-ferrous alloys. The technique of surfacing often differs from the usual fusion welding techniques. When the compositions and melting points of the surfacing and base metals are different it is usual to employ some form of " non-fusion " or " surface-fusion " technique, in order to avoid inter-alloying of the metals. Mechanical testing laboratory of the British Oxygen Co. Ltd., at Cricklewood. Surfacing and hardness. Various surfacing rods are discussed : Alloy steel surfacing rods ; 3½% nickel steel. Chrome-vanadium steel. Plain vanadium steels are used only to a limited extent. Wear-resisting alloy steel ; 12 to 14% manganese steel. Cast iron welding rods. Non-ferrous welding rods for building-up purposes. Brazotectic nickel bronze. Bronzotectic manganese bronze. Aluminium alloy rods for surfacing.

WELDING.

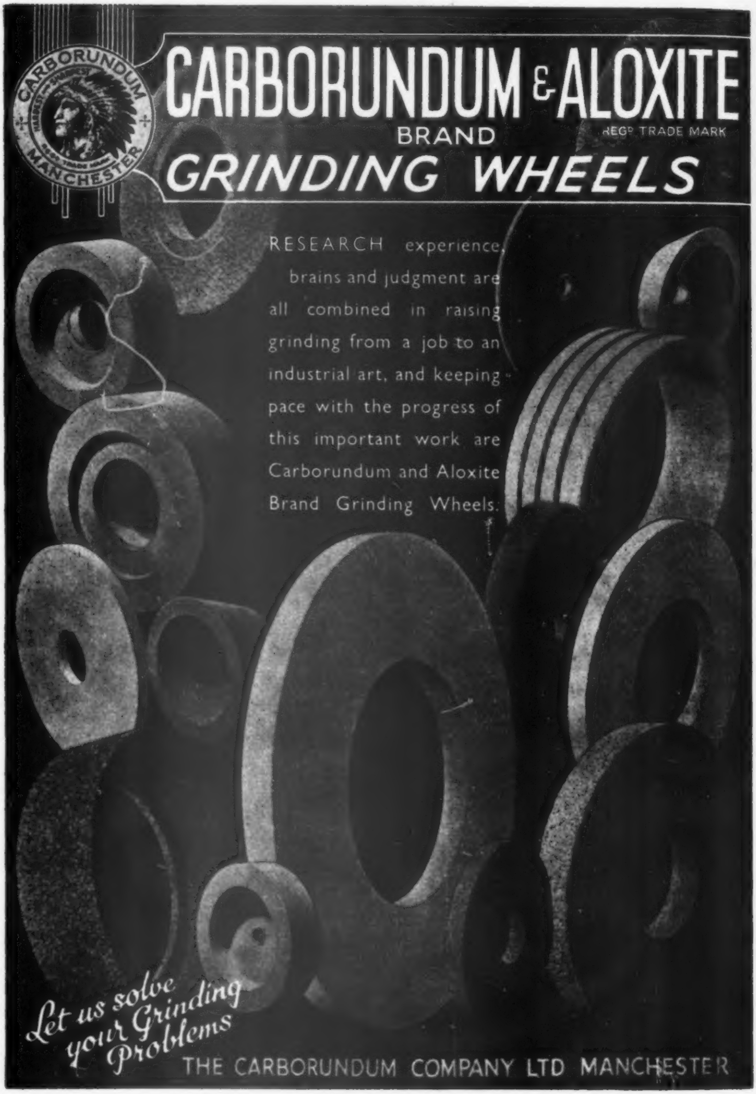
Welding Technique in Aircraft Construction, by Kurt Queitsch. (*Aircraft Engineering, April, 1940, Vol. 12, No. 134, p. 125, 9 figs.*).

Light alloy parts. Welding an aluminium tank. Correct and incorrect types of light-alloy welding seams. Welded aluminium gravity tank (Junkers). The flanging of light alloy tubes. Aluminium air intake-manifold (Dornier). Attachment fitting for the shock-absorber leg of a Junkers Ju.52 during manufacture.

Electric Spot and Seam Welding of Light Alloys, by C. Haase. (*Z.V.D.I., Vol. 84, No. 6, February 10, 1940, p. 89*).

Electric welding of light alloys still presents difficulties, mainly because the much lower electric resistance of the light alloy prevents the seam being maintained at the requisite temperature unless very much greater current densities are employed (30,000 to 45,000 amps.). These currents can only be maintained for a very short time (one-fifth second) otherwise the material undergoes structural changes and the electrode is affected. The current control can be carried out purely electrically by means of valves (thyratrons), or mechanically by means of a special cascade transformer. The latter method is more robust and requires less skilled attention. A single one of these modern transformers will operate simultaneously four spot welding or two seam welding machines, which reduces operative costs and produces a more favourable electric loan on the supply system.

The electrode pressure must also be adjustable to suit the work in hand (100 to 300 Kg.) and after the optimum values of these three factors have been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determined, the electric circuit and welding machine must be able to work over relatively long periods under these conditions to ensure consistency of the weld.

The experiments described show how these factors vary for sheet metals of different thicknesses and composition as well as the resulting fatigue strength of the weld. Both ultimate and fatigue strength of such welded structures compare favourably with standard riveting. A welded fuselage can be completed in half to quarter of the time required for riveting. This new method of construction will require certain changes in design but its obvious advantages ensure the future of welded light alloy structure as soon as the data on strength characteristics are complete.

The Ideal Design for an All-welded Ship, by J. F. Wadling. (*The Welding Industry, April, 1940, Vol. 8, No. 3, p. 81, 7 figs.*).

This paper opens with a brief explanation of the major considerations which confront the designer of an all-welded ship. The necessity for a revision of the structural design and constructional processes is emphasised, and a critical analysis is made of the effect on the design of the problems involved in the practical applications of arc welding and the limitations imposed by the plant available. Details of the principal changes from the riveted design are indicated.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research)

ACCOUNTING.

What the General Manager Thinks About, by R. T. Kent. (*Mechanical Engineering, May, 1940, Vol. 62, No. 5, p. 370*).

What does the general manager think about? First, last, and all the time, profits. Everything else stems from that. He thinks about a lot of other things, but if there are no profits, he will not very long have to think about any of these things, for with lack of profits his company will, within a longer or shorter time, fold up and die. Profits—the prime consideration. First problem is volume of sales at a profit. What is a budget? Budget is a yardstick. How the budget works. Reduction of costs important to manager. Product design and production methods demand attention. Sales policy is important to success. Manager cannot overlook advertisisng policy. Public relations allied to advertising. Labour relations—" a tough mug, but square." The real job is to make profits.

Factory Control as an Aid to the Office Manager, by B. T. Hamnett. (*The Cost Accountant, April, 1940, Vol. 19, No. 11, p. 246*).

Cost accountancy consists of " increasing net profits by eliminating waste and increasing efficiency." Directly chargeable expenses. Indirect charges. Standing charges. Non-recurring expenses.

FOUNDRY.

The Centrifugal Casting of Metals and Alloys, by J. E. Hurst. (*Machinery Lloyd, 18th May, 1940, Vol. XII, No. 10, p. 25, 5 figs.*).

In all cases the casting machines can be considered conveniently under the three essential headings—(*a*) the means adopted for the rotation of the mould; (*b*) the method of pouring or introduction of metal into the mould; (*c*) the form and construction of the mould. Holroyd vertical centrifugal casting machine. De Lavaud centrifugal casting machine. Diagram showing sequence of operations (Stuart). Centrifugal processes for purification of pig iron as developed by Jarotsky, Vroonen, Bradleys.

GEARING.

Gears and Gear Cutting, by W. A. Tuplin. (*Practical Engineering, May 18, 1940, Vol. I, No. 17, p. 661, 6 figs.*).

Profile checking of worm gears. Checking a worm thread of the involute helicoid type with a straight edge. The principle of an instrument for testing spur or helical gears. The corrections to the individual readings given by this instrument are made by recording them graphically. Pitch-testing. An instrument for measuring adjacent pitch errors in large gears. Checking the accumulated pitch error in a half revolution. An instrument for checking the spiral angle and concentricity of helical gears. Checking by running together.

A New Gear Tooth Hardening Machine. (*The Engineer, April 19,1940, Vol. CLXIX, No. 4397, p. 384, 4 figs.*).

The new "Shorter" type surface flame-hardening machine embodies a number of improvements. This process, which is particularly intended for gear tooth hardening, consists briefly of rapidly heating the surface to be treated by a moving high pressure flame which is followed immediately by jets of water that quickly quench the heated area. This gives a hardened surface layer which gradually merges into the softer metal of the core. The illustrations show : the machine head and carriage, an assembly of the hardening machine, the carriage drive.

HEATING, VENTILATION.

Developments in Domestic Heating. (*Mechanical Engineering, March, 1940, Vol. 62, No. 3, p. 203*).

A symposium of papers on various phases of the domestic heating problem condensed to serve as a review (I) of the developments in low-pressure heating-boiler design and construction, for hand and automatic firing, together with the present trends and future possibilities, as well as methods for rating and testing ; (II) the advance of the domestic oil burner in its 20 years of intensive progress, and the present-day improvements in methods for burning low oil rates economically in combination with inexpensive heat-absorbing members ; (III) the increasing use of anthracite as a domestic fuel brought about by improvements in automatic stoker firing ; (IV) by-product coke as fuel, modern processing methods, advantages in high heat value, and elimination of smoke, hand firing, and automatic stoker firing of this fuel ; (V) the increasing adoption of gas by the domestic-heating market in the field of warm-air heating, and in multifamily dwellings.

JIGS AND FIXTURES.

How to hold the work, by J. R. Longstreet and W. K. Bailey. (*The Machinist, April 27, 1940, Vol. 84, No. 10, p. 130, 9 figs.*).

Work held accurately can be finished accurately—if held rigidly it can be machined with proper speeds and feeds. Parallel closing collet chucks can be fitted with round, square or hexagon bushings. Solid jaws are used for heavy work. In the pushout type collet the plunger forces the collet into the hood, which causes the collet to tighten around the stock. The drawback type spring collet operates in the same way, except that the collet is drawn back against the tapered hood. The stationary type collet provides accurate endwise location, but is not as accurate from the standpoint of concentricity. The drawback extra-capacity collet provides accurate endwise location of the work piece. Both solid and adjustable types of end stops are used for second operation work. The stop is held between the plunger and the collet.

Chucks and holding fixtures, by J. R. Longstreet and W. K. Bailey. (*The Machinist, May 11, 1940, Vol. 84, No. 12, p. 166, 9 figs.*).

There are three general classes of chucks : (1) universal chucks, of the geared scroll, geared screw or box type where all jaws move together ; (2) independent chucks, where each jaw is operated separately ; and (3) combination chucks, where each jaw may be operated independently but where all jaws can be moved as a group, as with the universal chuck. In addition, there are power-operated universal and combination chucks. Air or hydraulic chucks used under low pressure to avoid distortion of work require locking devices in jaw linkage to overcome effect of centrifugal force. Special jaws for better grip. Precise second operations. Broad surfaced rocking jaws will hold

frail work without distortion. These jaws provide six contact areas on the work. Pinch jaws frequently are used for frail work. The jaws are tightened only enough to hold the work in place, then the set screws are tightened. The split ring method of holding frail work distributes pressure evenly over the entire surface of the work.

Laminated Material for Jigs and Fixtures. (*British Plastics and Moulded Products Trader, April, 1940, Vol. ii, No. 131, p. 487, 6 figs.*).

Physical properties of usual materials for jigs and fixtures. Ultimate tensile strength. Shearing stress. Modulus of elasticity. Specific gravity. Weight. Brinell hardness. Paper Laminated. Fabric laminated. Cast iron, steel machinery, aluminium ; alloy, cast, wood. Drill jigs and fixtures. Milling fixtures. General points of view.

MACHINE ELEMENTS.

Factors in the Fatigue of Helical Springs, by R. R. Tatnall. (*Mechanical Engineering, April, 1940, Vol. 62, No. 4, p. 289, 6 figs.*).

A compression spring which has given trouble from fatigue failures, is taken as an example for which the complete analysis problem is worked out. Dimension specifications. Load specifications, graphical presentation of working cycle of spring. Induced vibration of helical springs. Results of fatigue tests on springs. Range of endurance limit in commercial, oil-tempered spring wire. Comparison of true working cycle and endurance limit range. Effect of physical properties of materials. Comparison of fatigue properties of material with fatigue requirements of spring.

MACHINING, MACHINE-TOOLS.

Automatic Step Drilling of Deep Holes, by E. Hirvonen. (*Mechanical Engineering, May, 1940, Vol. 62, No. 5, p. 375, 7 figs.*).

The automatic step-drilling method is especially adapted for drilling holes in parts that cannot be rotated around the axis of the hole, such as oil holes in crankshafts where the drill has to be removed from the hole to free it from chips. The drill is suitably rotated and reciprocated by the mechanism of the machine. The cycle of drilling a hole consists of fast approach toward the work, a cut into the work at the proper feed rate, a rapid return out of the hole to clear the drill and hole of chips, and a rapid advance of the drill to the bottom of the hole for another cut. Feed rate and type of drill used. Cooling the drill. Length of drilling step. Rate of feed and cutting speed. Diagram of hydraulic step-drilling mechanism. Typical step-drilling machines Crankshaft line in an automobile factory. Six-spindle machine for drilling at one setting all oil holes in the crankshaft of a six-cylinder engine.

Grinding and Lapping Machine for Sintered-Carbide Tools, (*Engineering, April 26, 1940, Vol. 149, No. 3876, p. 435, 4 figs.*).

Absolutely smooth edges are necessary on both the clearance and rake sides, and the exact cutting angles required must be maintained in all re-grinding and lapping operations. The maintenance of a smooth cutting edge has many advantages from the point of view of production. It is desirable that a diamond lapping should follow the pre-grinding of a tool stock and the grinding of the carbide tip. Proper control of the tool may be obtained by means of two quadrants operating in planes, at right angles. The double wheel grinding and lapping machine, which is illustrated, in addition to

being equipped with the double quadrant arrangement, has the advantage that the tool may be brought into contact with either side of either the grinding or the lapping wheel without interfering with its setting in the tool holder.

MACHINING WITHOUT MAKING CHIPS.

Metal Spinning Comes of Age, by T. J. Salow, Jr. (*Machinery Lloyd, May 4, 1940, Vol. XII, No. 9, p. 26, 11 figs.*).

Metal spinning has a great potential usefulness in industry : (1) its range could be widened to include ferrous metals ; (2) its scope could be expanded in order to form intricate shapes in hard modern alloys ; (3) and if this work would measure up to exacting industrial standards of precision. The various steps involved in spinning a simple shape are illustrated. New tools were developed for increasingly heavy gauges of non-ferrous metals, they were applied—with adaptations—to modern ferrous alloys that had previously been wholly beyond the ability of the spinning lathe. Spinning stainless steel. Stainless spinnings help food industries. A Diesel engine injector sleeve spun of copper 0.109 in. thick—tolerances are extremely close. A miniature scale model of a steel beer barrel that is an exact copy of the finished product.

Hot Forging Practice, by H. J. Bromley. (*The Australian Engineer, March 7, 1940, Vol. 40, No. 286, p. 21, 4 figs.*).

Hydraulic forging press. Die steels used for this process graded according to the number of forgings required from the die over the period before recutting the type of material forged, the limits of accuracy required, and the peculiarities of shape and also the thickness of the various sections of the forgings. Table of the most common grades of die steels used. Example : A well designed connecting rod. Design factors. Connection rod design showing undesirable factors for manufacture by drop forging method. Keep the shape of the fo.ging as simple as possible giving full consideration to sectional shapes most easily produced by ordinary shaping, boring, drilling or milling operations in the dies. A typical drop forging die layout. Type of material to be forged. Thickness of forging sections. The weight of the finished forging and the relative amount of manipulation to take place in the die. Peculiarities of shape and justifiable die cost for production of limited quantities of forgings. Dimensional tolerance. The secret of successful mass production of drop forgings may be said to lie in the design of the necessary dies.

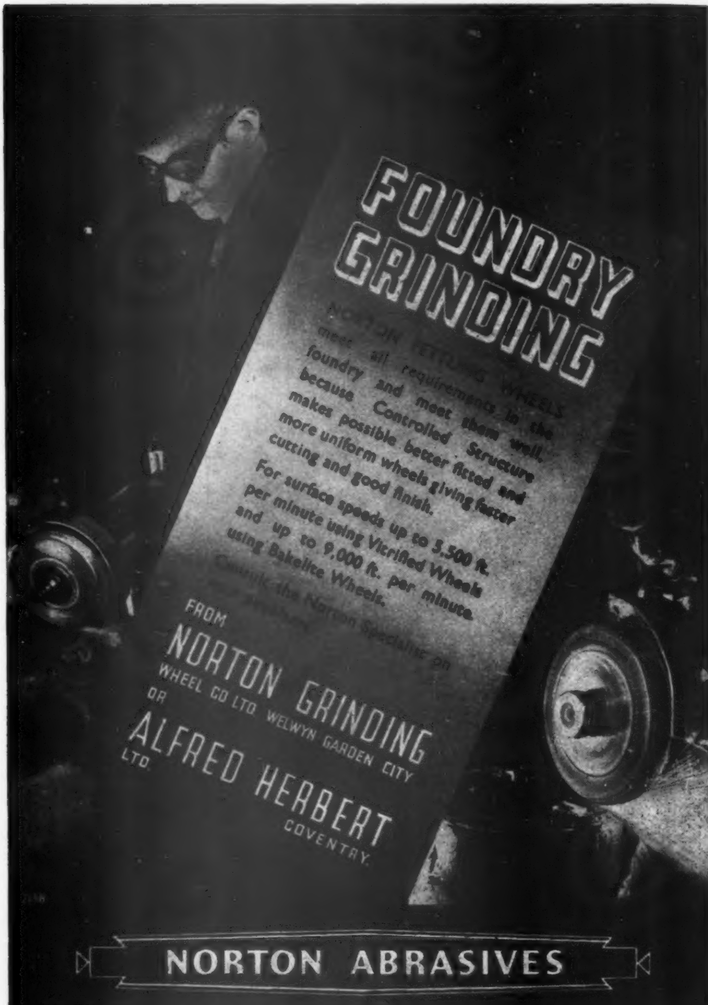
Installation et entretien des presses aerohydrauliques. (*Installation and Maintenance of Aero-hydraulic Presses*) by L. Scherer. (*La Machine Moderne, April, 1940, Vol. XXXIV, No. 382, p. 155, 3 figs.*).

The aero-hydraulic presses are used particularly for ring-tyre fastening, keying the rings, and work which does not need too great pressure. General arrangement and installation of a plant of aero-hydraulic presses. Function of the press. Various governing gears. Maintenance of aero-hydraulic presses. Sources of bad functioning.

MANUFACTURING.

Machine-shop Operations on All-metal Aircraft Parts. (*Machinery, May 16 1940, Vol. 56, No. 1440, p. 197, 17 figs.*).

Methods employed in the production of the Blenheim Bomber. Fork ends machined on a battery of Churchill-conomatics. Tool layout for machining a high-tensile steel fork end. Sequence of operations in the production of



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the tube-end socket. Capstan and turret lathe operations. Milling operations. Serration broaching and milling.

Geodetic Construction, by C. M. Poulsen. (*Aircraft Production, June, 1940. Vol. II, No. 6, p. 180, 31 figs.*).

Assembly of Wellington fuselages and wings : works layout and equipment.

MATERIAL.

Magnesium for Aircraft Construction, E. W. Conlon, J. Aeron, Sci., U.S.A. *Vol. 7, No. 6, April 1940, p. 252.*

The present status of magnesium as a material for aircraft construction is similar to that of aluminum in about 1922, and the material is going through the same stages of development. Of the new alloys that are constantly being introduced, the designer should consider only those alloys rated A or B by the producer, as regards corrosion resistance, and alloys with low elongation as compared with aluminum alloys should be avoided.

Static tests referred to in this paper prove that magnesium alloys are satisfactory from a strength-weight standpoint, although much more research must be done to determine the most efficient forms, particularly extrusion and corrugation.

Full-scale static and service tests on wings, fuselages, or tail surfaces must be made to definitely prove that the material and method of surface protection are satisfactory under actual service conditions.

The practice of some manufacturers to use magnesium alloy sheet for fairings and cowlings appears to be a hard way of learning how to fabricate the material. These parts are difficult to form in any material, and strength is a minor consideration. It would seem more practical to first use magnesium sheet where little forming is required and where the high buckling strength is important, such as the covering of a wing or fuselage.

The stamped butt-welded or cast wing and fuselage may offer as much possibility for low-cost quantity production as any of the various plastics which have recently been suggested.

MATERIAL TESTING.

Tests for the Deep-Drawing Qualities of Sheet Metal, by H. W. Swift. (*Sheet Metal Industries, May, 1940, Vol. 14, No. 157, p. 497, 3 figs.*).

The three types of action ; bending, stretching, and drawing, occur together in most types of press operation, but in varying degree. Of the three, bending appears to present little difficulty in practice, though it is the subject of a non-standardised standard test. Stretching may occur without drawing in certain shallow pressing operations, but drawing does not occur without stretching under any normal conditions, and when material fails during pressing it almost invariably fails in a region subject to stretching as distinct from drawing. The results may conveniently be grouped as follows :—(1) relationship between blank diameter, punch load and success in drawing (2) Strains and stresses produced by cup formation. (3) Effect of drawing conditions ; blank-holding, clearances, curvatures, speed, lubrication.

Brittle Lacquers as an Aid to Stress Analysis, A. V. de Forest and G. Ellis, J. Aeron, Sci., U.S.A. *Vol. 7, No. 5, March, 1940, p. 205.*

The fracture of brittle coatings has long been recognised as a method of checking strain distribution. Flaking of brittle mill scale at the yield point of local areas was used in the testing of the first wrought-iron bridges. More

recently brittle resin coatings which will fracture within the elastic range of most matrrials have been developed to give good qualitative pictures of strain distributions.

The present work describes an improved brittle coating in the form of a sprayable lacquer which air-dries over night to form a coating of uniform brittleness within the limits of thickness of three to eight thousandths of an inch. A calibration method is described whereby quantitative values of strain may be estimated within fifteen per cent.

MEASURING METHODS.

The Use of X-rays in Inspection Methods, by G. E. Bell. (*Practical Engineering, May 18, 1940, Vol. I, No. 17, p. 668, 6 figs.*).

Typical X-ray spectrum. Effect of filtering on spectrum of X-ray beam. X-rays are capable of blackening photographic emulsions, the laws of this photographic action being essentially similar to those which hold for the blackening by visible light. They are also capable of producing fluorescence in certain materials, notably barium platinocyanide, calcium tungstate, and zinc sulphide. A radiograph is essentially a shadowgraph produced by a source of radiation of finite size, and showing details arising fron the different parts of the object radiographed. Effect on definition of an X-ray focus of finite size. Effect of scattered radiation. Multiple exposures. Detail revealed by radiography. Radiograph of a light alloy die-casting, showing blow-holes, inclusions and inter-crystalline porosity. Photograph of a steel casting and radiograph of part of it. The radiograph shows a large blow-hole and many smaller cavities.

Deformation and Fatigue of Metallic Materials as Detected by X-Rays. F. Regler, Forschungsarb. Metallkunde Rontgenmetallog., Germany, *No. 26, 1939, p. 98.*

Deformation of metals causes both peripheral and radial broadening of X-ray diffraction spots. A number of examples of peripheral broadening brought about by cold deformation and fatigue are shown. With moderate reductions the spots tend to merge to form lines and with increasing reduction the well known fibre structures result. The significance of radial broadening is discussed. Measurements of this indicate that radial line width tends to a maximum which characterises the material; this is termed the " fracture line width." This was 6.30 mm. for pure iron and as high as 7.80 for some alloy steels. On fractured specimens the line width rises slowly to a maximum at the point of fracture. On notched specimens the width increases abruptly at the notch. The maximum of the line width on materials subjected to fatigue but not fracture was found to indicate where fracture would ultimately occur. Measurement of the line width in and near welds indicated positions of stress concentration. Several practical applications of radial broadening of X-ray lines are given and detailed directions for X-ray study of fatigue damage are given.

New High Temperature X-Ray Camera. E. C. Ellwood, *J. Inst. Metals, March 1940, p. 87.*

The camera is designed to study the constitution of alumium-zinc alloys at temperatures above 275°C. The X-ray tube used is of the demountable, hot-cathode, continuously evacuated type with an output of 25 m.a. at 50 kV., using copper radiation. To prevent oxidation, the specimen is sealed in a thin silica container; this is placed in a hole drilled in a steel rod, the rod being adjustable from a rotating head. Heating is carried out entirely by radiation from two similar china clay-alumina pots placed mouth to mouth with a 2 mm. gap between, the pots being heated by the electric resistance


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method using Bright-ray wire. The film is held to a detachable film carrier which can be removed without disturbing the position or temperature of the camera.

Optical-mechanical Checking of Aircraft Jigs, by A. Schofield. (*Machinery, May 9, 1940, Vol. 56, No. 1439, p. 165, 11 figs.*).

In connection with large assembly jigs and fixtures the difficulty has always been in finding an efficient means of checking their dimensional accuracy in all planes, and providing for a periodical quick inspection, to ensure that this accuracy is being maintained while the jig, or fixture is being used for the manufacture of the component parts for which it is intended. The equipment employed comprises a sighting telescope ; a collimator ; sighting targets ; micrometer trammels ; and an inclinometer or spirit level (Taylor, Taylor & Hobson, Leicester). Method of measuring tilt with the collimator and telescope. Method of measuring displacement with the telescope and sighting target. Chart giving the sequence of operation when checking a series of locations nominally in line. Optical bracket for mounting equipment on jigs. Method of checking an Aileron assembly jig. Method of checking a tail-plane jig. Method of testing a jig 32 feet long.

Spring Joints in the Construction of Measuring Instruments, by H. Stabe. (*Z.V.D.I., Germany, Vol. 83, No. 45, November 11, 1939, p. 1189*).

By comparison with point-, spindle- and knife-edge bearings, wires and bands which are subjected to bending and torsion by the forces to be measured, offer the advantage of considerably smaller internal friction, and therefore greater sensitivity. The reliability and transportability of such instruments is also important. The disadvantage, that the angular deflection is limited and the spring joints are subjected to directional force can be avoided by balancing the forces to be measured against forces in the springs. Examples are given, and illustrated by sketches, of the use of spring joints in accoustics (tuning forks, strings), mechanics (spring-balances and dynamometers-, pendulum- and balanced-suspensions, torsion balances, balance wheels, membranes, tube-, corrugated tube-, and leafe springs, etc.) and in electrotechnology (band suspension of galvanometer coils, vibration galvanometers, oscillographs, electrometers with metallised quartz fibres, electromagnetic measuring instruments with spiral spring suspension). Brief reference is made to the properties required of the materials of the springs, calculation of the latter (effect of shape and of cross-section), their mounting and damping.

MECHANICS, MATHEMATICS.

Torsional Damping Recorder. (*Automobile Engineer, April, 1940, Vol. XXX, No. 396, p. 119, 4 figs.*).

Torsional damping capacity may be defined as the amount of work dissipated into heat by a volume of material during a complete reversed cycle of stress. Cambridge torsional damping recorder provides a single record giving a complete curve connecting damping capacity with stress over the whole possible working range. It can be used to measure any metal, while wood and many plastics, such as ebonite and bakelite, can also be tested. Principle of operation. Diagram of optical recording method. Methods of recording.

The Distribution of Load on the Threads of Screws, by J. N. Goodier. (*J. App. Mech., U.S.A., Vol. 7, No. 1, March, 1940, p. A10*).

The distribution of load on the threads of screws and the types of deformation affecting it have been investigated by means of extensometer measurements made on the outside of the nut. The types of deformation characteristic of concentrations of load on different parts of the thread were found by

using a bolt carrying only a single turn of thread. At low loads the deformations of nuts with complete bolts closely resemble the effects of the artificial concentration of load on the base part of the thread, whereas there are marked contrasts with the effects of loads concentrated at the middle or at the free end. At higher loads a more uniform distribution is indicated. Similar conclusions follow from the application of an approximate method for deducing the distribution from the deformation measurements.

It is shown that the distribution is governed by (*a*) stretch and compression in bolt and nut, respectively, which are primarily responsible for concentration at the base ; and (b) by bending of the thread, circumferential stretch (at the base), and contraction (near the free end) of the nut wall, which have comparable effects in reducing the concentration.

POWER, DRIVE.

The Control of Machine Tools, by H. C. Town. (*Machinery, May 16, 1940, Vol. 56, No. 1440, p. 207, 17 figs.*).

Electric drive unit carried on a hinged bracket at the rear of a lathe bed. Box-type lathe standard carrying the driving motor and cone pulley. Gear change mechanism comprising co-axially mounted levers, gear segments, and racks. Gate-change arrangement for obtaining four speeds. Single-lever control for sliding gears giving 12 speeds. Feed gear box giving 12 changes with single-lever control. Friction-drive mechanism giving stepless speed variation. Single-lever mechanism for controlling nine lathe-spindle speeds. The control of milling machines. Close-up view of milling machine with dial control for speeds and feeds.

PSYCHOLOGICAL INVESTIGATION.

Power and Velocity Developed in Manual Work, by C. A. Koepte, and L. S. Whitson. (*Mechanical Engineering, May, 1940, Vol. 62, No. 5, p. 383, 14 figs.*).

In an attempt to learn more about the factors affecting the performance of all manual operations, studies of the maximum velocity of certain common hand motions and the maximum power developed in them have been carried on in the industrial-engineering laboratory of the University of Minnesota. It is believed that, through such studies of elemental motions, relationships can be found which could not be discovered through the study of more complex manual operations involving a large number of uncontrolled variables. Method of measurement. Results of tests.

SMALL TOOLS.

Turret Lathe Drilling Practice, by F. H. (*Mechanical World, May 3, 1940, Vol. C VII, No. 2783, p. 388, 11 figs.*).

Correct and incorrect angles for drills following centring tool. Centring tools combined with flat facing and with chamfering cutters. Extension holder taking drill sockets for taper or parallel shanks. Drill-holder with cored bushing for easy chip flow, and split collet holder. Plain holder for flat drills ; pads outside setting screws. Drill for Bakelite ; for brass and bronze for aluminium and copper. Good type for small deep holes in brass. Examples of flat drills easily and cheaply shaped for brasswork, etc. Inserted-point drill with coolant supply through flexible pipe connection. Arrangement of supply through turret.

The Corners of Rotating Tools, by F. H. (*Mechanical World, May 17, 1940, C VII, No. 2785, p. 433, 8 figs.*(.

The factors which influence shape for economical production. Question of rake, free cutting, easy starting, chip clearance, concentric accuracy, style of

termination of the cut required, and durability and tool strength have to be considered. Trepanning cutters shaped for chip breaking. Variations of reamer corners. Chucking reamers with chamfered corners, one having relieved teeth, the other being of the rose type. Die-head chaser with corner at 20°. For close-up threading the end is ground to 30°, Slitting-cutter teeth varied for chip breaking. Staggered spiral teeth for part grooving. Some shapes of face mill corners.

Chromium Plating an Indispensable Adjunct to the Tool Room—I. (*British Plastics and Moulded Products Trader, April, 1940, Vol. 11, No. 131, p. 468 2 figs.*). **II.**—*May, 1940, Vol. 11, No. 132, page 514, 4 figs.*)

Table No. 1—Increased efficiency derived from chromium-plating on miscellaneous metal working tools. Efficiency ratio of number of operations with plated tool to number with unplated tool. Table No. 2—Results recorded of drilling ebonite with chromium-plated drills. Re-sharpening and replating. Time of operating in hours. Number of holes drilled. Table No. 3—Action of chromium-plating solution on metals one week's immersion. (2) The electrolytic and plating conditions. Table No. 4—Commercial chromic acids for electro-plating per cent. purity. (3) Precleaning and after-washing. (4). Special measures, stopping-off, anodes, etc. (5) Thickness of deposit and precautions in preparing tools. The average thickness of deposit for general classes of tool work varies from 0.0002 in. to 0.0005 in., and for some classes of work, a thickness of chromium between 0.004 in. and 0.006 in. is regularly deposited while again upon occasion ever heavier platings may be required. The tool and the amount of mechanical finishing in the nature of grinding, lapping, polishing required after plating are the chief determining factors. (6) Stripping for replating. (7) Control of the plating solution. Conclusion. The tool user by building up a sound chromium plating practice as a section of the tool room can undoubtedly prolong tool runs and therefore effect substantial monetary savings. The hardness, wear-resistance, and low coefficient of friction properties of chromium should be pressed into service to more universal advantage.

Die Design and Construction, by C. R. C. (*Machinery, May 2, 1940, Vol. 56, No. 1438, p. 147, 6 figs.*).

Design of the cutting-off punch. Spring stripper used in a forming, piercing- and cutting-off die. Construction of the die shoe. Construction of the punch shoe. Gauging methods where greater accuracy is required. Arrangement of end gauge for a cutting-off die. Gauge support for long flexible steel strip. Methods of finish gauging.

SURFACE TREATMENT.

The Polishing, Plating and Anodising of the Aluminium Light Alloys, by E. E. Halls. (*Metallurgia, February, 1940, p. 123*).

A description is given of the physical and chemical properties of aluminium and its light alloys, in so far as these affect the general machining and electroplating of these metals. The final stages of polishing and the use of laquers are dealt with in detail. Regarding electro-plating, the importance of each operation is explained, and how a sound surface may be obtained which shall give some protection against mechanical maltreatment and corrosion. The review given of anodising extends over precleaning, the choice of suitable electrolytes for different alloys, impurities, pigmenting and the nature of the final film, with a recommendation as to the best selection of these actions for resistance to corrosion.

TECHNICAL INFORMATION.

We Are At War, by Sir Alfred Herbert. (*Machinery, May 9, 1940, Vol. 56, No. 1439, p. 183*).

Labour and night-shifts. Dilution of skilled labour. Training. Women's work. Shortage of material. Conclusion : The 3-shift system of eight hours per shift is the ideal. Dilution is advocated by bringing all unemployed into the industry and by the introduction of women to the fullest possible extent.

WELDING, BRAZING.

Welding as a Substitute for Casting, by S. F. Dorey. (*The Welding Industry, May, 1940, Vol. VIII, No. 4, p. 116, 8 figs.*).

The following welded examples are illustrated : columns and bed plate for turbo-compound steam engine ; mild steel exhaust turbine casing and eduction pipe ; bedplate and cylinder entablature for auxiliary oil engine for a ferry boat ; auxiliary engine bedplate ; steam condenser complete ; gear case ; bedplate for a heavy oil engine ; stator, 23 ft. diameter, of a 24,000 kVA water wheel alternator.

Tentative Standard Methods for Mechanical Testing of Welds. (*Welding Journal, March, 1940, p. 201, 10 figs.*).

These standards have been prepared by the Committee on Standard Tests for Welds of the American Welding Society. The report deals with the weld metal, butt welds and fillet welds. Weld metal is to be tested by its density soundness as shown by an etch test, and its tensile strength : butt welded joints by a nick-bend test, a guided-bend test, tensile strength and ductility ; fillet welded joints by a weld-break test, and shearing strength in transverse and longitudinal directions. The report gives dimensioned diagrams of the specimens and procedure and explains the units and significance of the results obtained from such tests.

INDEX TO ADVERTISEMENTS

Research Department: Production Engineering Abstracts

(*Edited by the Director of Research*)

ANNEALING, CASE HARDENING, TEMPERING

The Heat-treatment of Tool Steels, by R. C. B. (*Machinery, Part I : May 23, 1940, Vol. 56, No. 1441, p. 231. Part II : June 20, 1940, Vol. 56, No. 1445, p. 355*).

PART I : Variables in heat-treatment : temperature and time for annealing and method of cooling after annealing ; pre-heating temperature and time ; hardening temperature and time and atmosphere in hardening furnace chember ; quenching medium and temperature ; and tempering temperature and time. The research is concentrated in tables : (i) Normalizing temperature for carbon tool steel ; (ii) Normalizing time for carbon tool steel ; (iii) Hardening temperatures for carbon steel tools ; (iv) Tempering temperatures for carbon tool steel ; (v) Relation of tempering temperature to strength of 1.06 per cent carbon tool steel, quenched in brine from 1460 deg. F. PART II : (vi) Preheating time for high-speed steel with a furnace temperature of 1,600 deg. F. (vii) Relation of hardening temperature to cutting efficiency for five commonly used high-speed steels ; (viii) Time for treating high-speed tools in high-temperature furnace for hardening throughout ; (ix) Relative strength of 18-4-1 high-speed steel as affected by variations in the tempering temperature. Steel is oil-quenched from 2,400 deg. F. (x) Relative cutting efficiency and Rockwell hardness of various high-speed steels as affected by variations in the tempering temperatures.

Hard Facing—a Process for the Mechanical Engineer, by E. E. Levan. (*Mechanical Engineering, June, 1940, Vol. 62, No. 6, p. 459, 10 Figs.*).

Essentially, hard facing consists of welding onto wearing parts a coating, edge, or point of a hard metal, generally a special alloy possessing unusual wear resistance. By this method, metal surfaces which normally wear away rapidly in service are protected. Hard-faced parts will outwear plain or unfaced ones from 2 to 25 times, depending on the type of hard-facing alloy used and the service to which the part is subjected. Requirements and types of hard-facing materials : (1) Inherent hardness ; (2) Resistance to abrasion during use ; (3) " Red hardness," or the ability to retain initial hardness up to red heat and to be unaffected after cooling alowly from red heat ; (4) Ability of being easily applied by ordinary welding techniques ; (5) Resistance to high-temperature oxidation during application by welding ; (6) A melting point slightly lower than steel, the usual base metal ; (7) A coefficient of expansion close to that of the base metal ; (5) groups of wear-resistant alloys and hard-facing rods have been developed which fulfill to a varying extent the foregoing requirements which are discussed. Materials which can be hard-faced. Preparation of work. Welding methods. Oxyacetylene technique. Metallic-arc procedure. Hard-facing applications. Undercutter bits for coal cutting machines. Car retarder parts. Steam-valve gates and rings. Shieldings to protect stainless steel turbine blades. Seating surface of an automotive valve. Sodium-cooled exhaust valves.

The Nitriding Process of Case-hardening, by J. E. Hurst. (*Machine Shop, May, 1940, p. 84, 1 Fig.*).

The hardening operation is carried out by heating the articles in contact with anhydrous ammonia gas for a given time at a steady temperature of approximately 500°C. During this operation nitrogen is liberated by the dissociation of the ammonia, and this is absorbed by the steel. The present range of alloy steels used for nitriding have the following alloy composition : Chromium 0.80 to 1.80 ; aluminium, 0.60 to 1.20 ; molybdenum, 0.15 to 0.25. In this country, six grades of steel are available, having carbon contents ranging from 0.20 to 0.65 per cent. Experience has shown definitely the necessity for removing the internal stresses likely to be present in the steel prior to nitriding. Time required for nitriding. The furnace used is the resistance type, and is provided with automatic temperature regulation. Layout of plant for nitriding.

Controlled Atmospheres, by A. Fisher. (*Machinery, June 13, 1940, Vol. 56, No. 1444, p. 321*).

Their influence in the heat treatment of steel. Heat treating in air. Flame curtain atmospheres. Coal-fired open furnace atmosphere. The atmosphere from cast iron borings. Gas from carborizing compound. Cracked ammonia. Burnt ammonia and other N_2H_2 mixtures. Partly burnt hydrocarbons.

ACCOUNTING, ADMINISTRATION.

The Interlock between Financial and Cost Accounts, by P. Phillips. (*The Cost Accountant, May, 1940, Vol. 19, No. 12, p. 261*).

Business need of accountancy. Accounting progress in business. Main principles of business. Outcome of research. The power of accounting. The measure of control. Necessity for the control of costs. Controlled accounts. Stores accounting—materials. Labour. Overhead expenses.

Job Evaluation—A Phase of Job Control, by C. W. Lytle. (*Personnel, U.S.A. May, 1940, Vol. 16, No. 4, p. 192*).

Review of job standardisation and job evaluation, Professor Lytle applies engineering analysis to job control as a whole and defines the inter-relationships of its various steps.

A Case History in Merit Rating, by Randolph S. Driver. (*Personnel, U.S.A., May, 1940, Vol. 16, No. 4, p. 137*).

In this case study of merit rating in the offices of the Atlantic Refining Company, Mr. Driver outlines five fundamental steps required for the successful application of merit rating to an industrial situation. The errors to which rating is susceptible are analysed, and the necessity of a qualitative approach is stressed.

BELTS AND ROPES.

The V-Belt Drive, by Francic N. Honey. (*Machine Shop Magazine, June, 1940, p. 48, 3 Figs.*).

Efficiency and theory of operation. V-belt versus flat belt. It is not practicable to use a crossed V-belt or a right angle turn, or fast and loose pulleys. Should it not be practicable to stop the machine to alter the speed, variable speed pulleys must be used. These pulleys are made in parts so that the grooves can be widened and contracted to allow the belt to operate at a lesser

or greater radius. The V-flat drive. V-drives for slow speeds. Table of belt characteristics. Belt section.—Width at top in inches.—H.P. range up to. Recommended min. pulley diameter of small pulley in inches. Table : arc of contact correction factors.

The War-time Use of Belting, by H. Stuart Jude. (*Power Transmission, May 15, 1940, Vol. 9, No. 100, p. 169, 3 Figs.*).

Three principal factors : (1) the loads transmitted are generally increased, (2) the belts work longer hours, and (3) there is appreciable less time in which to do the hundred-and-one maintenance jobs. The maintenance front. Initial tension. Unforeseen jobs. Degreasing. Dirt, dust and dressing.

COOLANT, LUBRICANT.

Some Technical Notes on Cutting Oils, by Alan Wolf. (*Machine-Tool Review, March-April, 1940, Vol. 28, No. 173, p. 66, 2 Figs.*).

Examination of emulsions under the microscope. Low temperature separation and flow tests in neat soluble oils and straight cutting oils. Corrosion tests on neat soluble oils. Corrosion tests on straight cutting oils. The lubricating quality of cutting emulsions. Mechanism of Lubrication by cutting emulsions. Determination of emulsion concentrations. Acidity and alkalinity of emulsions. Composition of soluble oils. Causes of gumming of slides.

EMPLOYEES, WORKMEN, APPRENTICES.

Adapting Training Courses to Meet the Present Special Needs, by L. D. McDonald. (*Practical Techniques of Industrial Training, Personnel Series (U.S.A.), No. 42, p. 3*).

McDonald represents the machine tool industry, and it is his belief that this industry has problems not found in other industries. Business as a whole must definitely adopt courses of training in order to provide a supply of semi-skilled and skilled labour for their own operations and from which they can draw in the future for supervisory and technical employees. Need for training. Young high school graduates were hired and put to work in the factory, keeping track of them as material from which employees for the various departments could be educated. The learner program. Each month the foreman is asked to fill out a questionnaire stating the progress of each learner. These learner courses now fulfil the purpose for which the apprentice courses of the older days were chiefly designed. Basic training plan altered. Getting young men from three sources : (1) from technical high schools, destined to become foremen, inspectors, assistants, superintendents, production and routing men, draftsmen, assistants to department heads, etc. ; (2) from the graduating classes of technical colleges. They will become expert engineers, plant executives, sales representatives, etc. ; (3) source—miscellaneous. They are neither graduates of technical high schools nor graduates of engineering schools. Three apprentice groups, regular apprentices, special apprentices, and technical apprentices. Operator training. An apprentice training programme is a means whereby a company aids a man to advance himself, helps him towards the realization of his ambitions and his opportunities.

Employment Stabilization and Experience Rating, by E. P. Schmidt. (*Personnel (U.S.A.), May, 1940, Vol. 16, No. 4, p. 163*).

The fundamental management principle of "Coordination." If there is good coordination between the sales department, the manufacturing organisation, and the personnel department, much can be accomplished towards

reducing seasonal and casual unemployment, and, indeed, towards reducing the vast and total unemployment.

The Foreman's Role in Management, by E. B. Roberts. (*Personnel (U.S.A.) May, 1940, Vol. 16, No. 4, p. 207*).

The foreman emerges into a new world of enlarged opportunity, where his task is not merely to get things done but to get things done harmoniously. The three-fold task of the foreman, of the '40's.

GEARING.

Epicyclic Gear Analysis IV, by A. B. White. (*Power Transmission, May 15, 1940, Vol. 9, No. 100, p. 157, 2 figs.*).

Efficiency governed by tooth friction, bearing losses, oil churning. Variations in efficiency due to changes in ratio.

MACHINE TOOLS, MACHINING METHODS.

Metal-Cutting Power Calculations, by P. H. Miller. (*Machinist, March 2. 1940, Vol. 84, p. 23*).

Formulae for obtaining power requirements for machining a variety of metals. With the object of determining (1) the relationship (if any) between the physical properties of the metal and the power required, and (2) relation of chip thickness and width to power requirements. Table I indicates power constants for ferrous metals and alloys, e.g. S.A.E. steels, plain cast iron, alloy cast iron, malleable iron, cast steel. Table II indicates power constants for non-ferrous metals and alloys e.g. brass, bronze, aluminium, monel (rolled), zinc alloy (die-cast).

Multi-tool Lathe Practice. (*Machinery, July 4, 1940, Vol. 56, No. 1447, p. 421, 16 figs.*).

Some interesting applications of special attachments and tooling on B.S.A. lathes. Constructional features of the machines. Taper-turning operations. Form-relieving operation on a piston. The high precision lathe. Application of the principle of step-turning. A shell-turning operation.

Driving Work in Production Lathes, by F. Horner. (*The Machinist, June 15, 1940, Vol. 84, No. 17, p. 198E, 10 figs.*).

Illustrations show catch-plate drive with arbor pin set to clear tool-block ; equalizing drive with floating pin ; slipping plate turning carrier ; rigid type of arbor mounting and equalizing driver ; driver plate embracing squared end ; piece driven by forged stem ; slotted plate and carrier drive ; crankshaft mounting ; direct transmission to work on stump arbor ; hexagon plug and forged hole drive for shaft ; expanding plug mechanism.

Typical bar stock set ups, by J. R. Longstreet and W. K. Bailey. (*The Machinist, June 22, 1940, Vol. 84, No. 18, p. 284, 18 figs.*).

Universal bar tools for turret lathes can be used for many different parts without making major set-up rearrangements. Set-up for first-chucking operations on an alloy steel shaft. A ram-type turret lathe used to make a shoulder stud from bar stock. Cross-slide and hexagon turret cuts combined. Second chucking for facing, chamfering, center drilling and necking operations on a taper stud. Tools for adjusting screw. Quantity to be produced will govern the tooling set-up.

Equipment for bar work, by J. R. Longstreet and W. K. Bailey. (*The Machinist, June 8, 1940, Vol. 84, No. 16, p. 242, 6 figs.*).

By using a permanent set-up of universal bar tools changes from one job to another become easy. Only collet bushings and cutters need be changed for most work. Layout for typical bar job. Selected operations. Reduced set-up time.

Deep holes in hot plates. (*The Machinist, May 25, 1940, Vol. 84, No. 14, p. 212, 3 figs.*).

Much of the success in bonding plywood depends on accuracy in machining hot plates and bases for the high pressure forming and curing presses. One of the major problems in making the presses is the deep drilling of these hot plates. In some sizes it is necessary to use drills as long as 48 in. The special drilling machine drills up to twelve holes simultaneously in sizes from $\frac{3}{4}$ in. up to $1\frac{1}{4}$ in. diameter. These plates are about $2\frac{1}{4}$ in. thick before machining. Silicon-killed steel is used.

Planing Machine for Marine Propellers. (*Engineering, May 17, 1940, Vol. 149, No. 3879, p. 500, 2 figs.*).

Constructed by Messrs. Morton Manufacturing Company, Muskegon Heights Michigan, U.S.A. The new machine can deal with propellers up to 20 ft. in diameter by 20 ft. pitch, and having a blade-root diameter of 4 ft. The blades can have either a true helical, or screw-thread, surface with a constant pitch, or can have a variable pitch, a curvature from root to tip, or a backward rake, i.e. with the radii of the blades not at right angles to the shaft axis. The figures show machine working as radial planer, machine engaged in circular milling. The ram has a reciprocating movement when a radial planing cutter is used and can be set at an angle in the vertical plane when raked blades are being dealt with. When the blade has a straight centre line with a combination of constant pitch at the outer sections and varying pitch towards the root, the operation is carried out in three stages. First, the outer portion of of constant pitch is planed, then datum lines for the remainder of the blade are milled at the appropriate pitch for each radius, the final stage consisting of the grinding down of the ridges between the milled grooves. The cutting speeds of the ram range from 14 ft. to 100 ft. per minute in either direction of cut. The minimum incremental feed provided is equivalent to 1/64 in. on 15 ft. diameter, the corresponding maximum being approximately 15/16 in. Continuous feeding rates, such as would be used in milling, cover a range from 2 in. to 12 in. per minute at 3 ft. diameter.

18-ft. Universal Gear-Hobbing Machine. (*Engineering, May 17, June 14, 1940. Vol. 149, Nos. 3879, 3883, pp. 498, 577, 13 figs.*).

The machine, made by Messrs. The Power Plant Company, Ltd., West Dayton, as indicated by the term " universal," can be used for cutting either single-helical or worm gears, double-helical gears, ordinary spur gears, or worm gears of any diameter between 3 feet 6 inches and 18 feet on the pitch circle, the teeth being of involute contour and of any pitch up to 5 in. Either single-thread or multi-thread hobs can be used. The gear being cut has two faces, each $19\frac{1}{2}$ in. wide, with a space of 22 in. between them, the total vertical distance between the two hob spindles being thus 5 ft. 1 in. The gear, which is for a marine installation, has a pitch-circle diameter of 103.805 in. with 283 teeth of 1 in. normal pitch and 1.152349 in. circular pitch. The overall length of the machine is approximately 58 ft. 7 in., the overall width about 14 ft. 9 in., and height from the bottom of the main bed is 18 ft. 9 in. Vertical traverse is effected by double nuts and a screw of the same size and type as

that used for the horizontal traverse of the columns. This screw has a guaranteed accuracy of 0.01 in. in 6 ft., and is always in tension.

MACHINES NON-REMOVING CHIPS.

Hot Pressing of Metal Powders. Results with Powdered Alloys and Mixed Metal Powders, by W. D. Jones. (*Metal Industry (Lond.), March 8, 1940, Vol. 56, p. 225*).

Investigations on the hot-pressing of metal powders have been followed by a rapid qualitative survey of tensile and hardness characteristics of test specimens produced by hot-pressing of powdered alloys, and of hot-pressed masses formed from mixed single metal powders. Tests were made on properties of alloys of the brass type produced by synthesising the alloy from mixed metal powders, instead of from powdered alloy material. In all cases, the results obtained on the test pieces produced by synthetic methods were superior to those of the corresponding specimens of the alloy powder series. Tests on mixed powder brass and bronze alloys containing silicon, nickel and other modifying metals, showed no substantial improvement in properties resulting from such additions, thus continuing the conclusion that the physical metallography of alloys made from powders is radically different from that of similar materials produced by melting and casting.

The Edgwick Diecasting Machine. (*Machine-Tool Review, March-April, 1940, Vol. 28, No. 173, p. 51, 4 figs.*).

The casting of brass and aluminium which require higher temperatures presented certain difficulties. The heat to which the dies and pressure chamber were subjected caused rapid wear and porosity in the castings. The cold-chamber machine thus enables castings to be made at high pressure ensuring sound castings and long die life. General arrangement plan of the Edgwick diecasting machine. Typical examples of diecastings. The size of the die plates is 16 in. by 11 in. and the maximum projected area of casting which can be dealt with is 13½ square inches at 7,400 lbs. pressure per square inch.

MANUFACTURING METHODS.

The Production of the 40-mm. Bofors Anti-Aircraft Gun. (*Machinery, June 27, 1940, Vol. 56, No. 1446, p. 377, 48 figs.*).

Methods employed at a Royal Ordinance Factory to accelerate the supply of an important defence weapon. Cutter and cutter head used for the solid boring operation. Tools used on a turret lathe for the chambering operation Special gauges for checking the chamber. The rifling tool.

What it takes to turn stainless. (*The Machinist, May 25, 1940, Vol. 84, No. 14, p. 195, 7 figs.*).

A large tonnage user gives the results of 15 years experience in cutting stainless steels on automatics and turret lathes. Speeds and feeds for machining by stainless steel, turning, drilling, reaming, tapping, threading. Single-point cutting tools with steep side rake angles. Typical set-up for machining stainless steel parts on a 3½ in. four-spindle Conomatic. Drills, reamers, cutting off tools. Typical set-up on a B. & S. automatic, machining an adapter for a beverage bottling machine. Chemical composition of stainless steels containing C., Cr., Ni., S., Mn., Si.

Impressions of American Practice, by G. W. Clarke. (*The Journal of the Institution of Production Engineers, June, 1940, Vol. 19, No. 6, p. 231*).

Methods adopted in U.S.A. for the mass production of small electrical and other products. Close co-operation between machine tool maker and user is particularly stressed. Replacement of individual piece work by group systems is mentioned. Safety devices are criticised.

MATERIALS, MATERIAL TESTING.

Applications of Cast Iron in Modern Automobile Construction, by E. C. Toghill and R. V. Dowle. (*The Journal of the Institution of Automobile Engineers, March, 1940, Vol. 8, p. 253*).

The object of the review is to bring to the notice of the automobile engineer and designer some of the irons with special properties, for specific applications, and to show that the grading of cast iron and the choice of the correct grade for the purpose required is as important as in the case of steels. A summary is then made of (1) the effect of added elements (nickel, chromium, molybdenum, copper), and (2) the influence of elements commonly present. Mechanical properties and tests. Applications of cast iron in automobiles.

Nickel Alloy Cast Iron, by W. G. Wright. (*The Australasian Engineer, April 8, 1940, Vol. 40, No. 287, p. 15, 9 figs.*).

Increase in tensile strength of cast iron since 1860 from 5 to 26 tons/sq. in. tensile strength. Types of nickel cast iron. Those containing less than 2% nickel, hard and heat-treatable gray irons, with between 2 and 6% ; white iron castings with up to 5% nickel; austenitic cast irons, with nickel from 17 to 40%. Diagram showing the structure of nickel cast irons. Comparison of silicon and nickel cast irons. A graphic representation that alloy cast irons develop greater hardness than plain iron when quenched in oil. Effect of heat treatment on the strength and hardness of nickel cast iron. Heat treatment of nickel cast irons. Graphs showing the hardness, strength of core and chill depths for 3.5% and 2.8% total carbon irons when alloyed with increasing per centages of nickel and chromium.

Tests for the Deep-Drawing Qualities of Sheet Metal, by H. W. Swift. *Sheet Metal Industries, June, 1940, Vol. 14, No. 158, p. 608, 1 fig.*).

The cupping test can be regarded as representative of flanged pressings, while the drawing test is representative of pressings drawn through without a flange. The appropriate test in any particular case should be selected with a knowledge of the practical requirements. There are, of course, many pressings which range from one type to the other in different parts, and many in which the two types are superposed. The test apparatus which has been designed is shown.

MEASURING METHODS.

A Convenient Electrical Micrometer and Its Use in Mechanical Measurements, by Ross Gunn. (*Journal of Applied Mechanics, U.S.A., June, 1940, Vol. 7, No. 2, p. A-49, 5 figs.*).

A simple electrical micrometer of great mechanical and electrical stability has been developed. The electrical-current output from the micrometer is accurately proportioned to the impressed mechanical displacement. The least count of typical micrometers using portable microammeters as indicators and employing no amplification is 5/1,000,000 in. Zero drift, hysteresis, temperature, and pressure variations have been reduced to less than 1 per cent. Special circuits are described which permit the indication of the sums, differ-

ences, ratios, or products of mechanical displacements and hence are useful in many mechanical measurements. The micrometer is also convenient for zero and low-frequency vibration studies.

The Measurement of Liquid Level at a Distance, by J. R. Fawcett. (*Mechanical World, June 7, 1940, Vol. CVII, No. 2788, p. 9, 12 figs.*).

The methods used for measuring liquid level at a distance are based on one of the following : (1) A float on the surface of the liquid operating an indicator by means of a rope and pulley system. (2) The direct pressure method. (3) The air-balance pressure method. (4) An electrical transmitter operated by one of the fore-going methods. The illustrations show : Float-operated level indicator ; gauge mounted level with bottom of tank ; gauge for overhead tanks ; air balance method of liquid depth measurement ; air balance method for tanks under pressure ; dual liquid depth gauge ; diaphragm-operated liquid level gauge ; electrical transmitter, float-operated.

MECHANICS, MATHEMATICS.

A Photoelastic Study of Stresses in Rotating Disks, by R. E. Newton. (*Journal of Applied Mechanics (U.S.A.), June, 1940, Vol. 7, No. 2, p. A-57, 11 figs.*).

The recent experiments of Hetényi and others in developing a technique for " freezing " stresses in bakelite and other photoelastic plastics have broadened the scope of the photoelastic method of stress analysis. The new technique offers itself as a powerful tool in solving problems in which it is inconvenient to study the fringe pattern while the model is actually under load. This paper discusses the application of the technique to the determination of the stresses in rotating disks of uniform thickness having symmetrically placed non-central holes.

Problems of Twisted Surfaces, by A. Dickason. (*Sheet Metal Industries, June, 1940, Vol. 14, No. 158, p. 633, 6 figs.*).

Swan neck transition piece between parallel planes. Transition piece between planes at right angles. Elbow transition piece between angular planes.

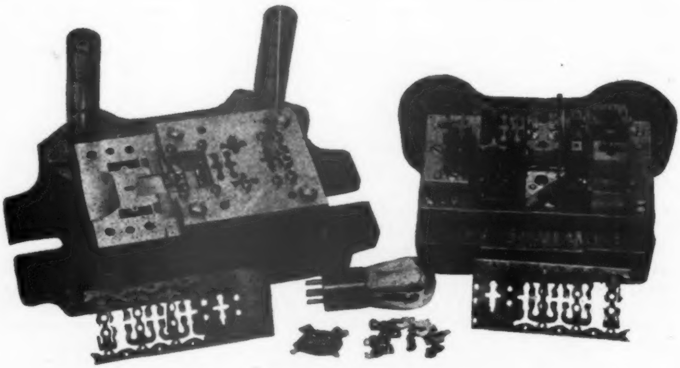
How to Tackle Problems Involving Intersections of Cones and Cylinders, by W. Cookson. (*Sheet Metal Industries, June, 1940, Vol. 14, No. 158, p. 641, 4 figs.*).

Pattern for conical branch connection. Alternative method for pattern. Conical hopper on inclined pipe.

POWER, DRIVE.

The Control of Machine Tools, by H. C. Town. (*Machinery, Part I : May 16, 1940, Vol. 56, No. 1440, p. 207, 17 figs. Part II : June 20, 1940, Vol. 56, No. 1445, p. 349, 10 figs.*).

PART I : Electric drive unit carried on a hinged bracket at the rear of a lathe bed. Box-type lathe standard carrying the driving motor and cone pulley. The control of geared mechanism. Speed change devices. The control of lathes. The control of milling machines. PART II : Controls on manufacturing milling machines. Direct duty drives. Drilling machine control. Grinding machines. Reciprocating machine tools. Shaping and slotting machines.



RESEARCH.

The Influence of Crystal Size on the Wear Properties of a High-Lead Bearing Metal, by J. R. Connelly. (*Transactions of the A.S.M.E., May, 1940, Vol. 62, No. 4, p. 309, 19 figs.*).

The present investigation was made to determine the effect on removal of the bearing-metal surface and the pressure at which the oil film breaks down as a result of variations in the crystalline structure of the bearing metal. Both the chemical composition of the bearing metal and the size of the specimen were kept constant. The crystalline structure was varied and the resulting change in properties determined.

SHOP MANAGEMENT.

We Are At War, by Sir Alfred Herbert. (*The Journal of the Institution of Production Engineers, June, 1940, Vol. 19, No. 6, p. 203*).

It calls for vast flow of munitions and mechanised equipment. Vital machines must work 24 hours a day. The problems of labour and night shifts, dilution of skilled labour, and the extensive introduction of female labour. The use of substitute materials and a stricter measure of economy would considerably relieve material shortage.

SMALL TOOLS.

The Machining of Non-Ferrous Metals, by J. F. Driver. (*Machinery Lloyd. June 1, 1940, Vol. XII, No. 11, p. 25, 3 figs.*).

CUTTING TOOL ANGLES FOR COPPER ALLOYS

Material	Top rake	Clear. rake
DUCTILE ALLOYS :		
Copper	25°	15°
Rolled phosphor bronze ...	20°	15°
Silicon bronze	15°	15°
BRITTLE ALLOYS :		
Yellow brass	6°	5°
Gun metal	5°	5°
Cast phosphor bronze ...	0°	5°
Aluminium bronze	10°	5°
" Leaded " alloys	5°	5°

SURFACE TREATMENT.

Electroplating Practice for Zinc Alloy Die Castings, by E. E. Halls. (*Metal Treatment, Spring, 1940, p. 39*).

A finish coating on zinc alloy die castings is required in order to secure the necessary protective and artistic effect, and, in view of the combined serviceability and attractive appearance of nickel and nickel-chromium coatings. Summary of practice now generally accepted as suitable for treatment of this class of material. Cleaning. Polishing or grinding. Cleaning prior to plating. Electroplating. Direct nickel plating. Copper + nickel plating. Chromium plating. Barrel plating. Current practice favours the use of a thickness of coating 0.00035 to 0.0007 in. for the nickel, and 0.00025 to 0.0005 in. for the copper layer. The chromium " flash " is usually of the order of 0.00001 in.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TECHNICAL EDUCATION.

A Works Training Scheme, by G. A. Hall. (*Industrial Welfare and Personnel Management, May, 1940, Vol. xxii, No. 258, p. 170*).

Works training scheme at British Thomson-Houston Co., Ltd., Rugby. Apprenticeship Committee. Apprentice training department. Trade apprentices. Boys into craftsmen. Training girls. Drawing office course. Engineering course. Technical training. Financial assistance. Encouragement. Safety first and sickness. Recreation.

WELDING, BRAZING.

The Welding of Light Gauge Steel, by S. G. P. de Lange and E. S. Waddington. (*The Welding Industry, June, 1940, Vol. VIII, No. 5, p. 147, 8 figs.*).

Some of the recent developments in the welding of sheet metal by electric arc welding and resistance welding. (1) The pressure to be applied. (2) The amount of heat to be applied. (3) Suitable means of current control. (4) The size and types of electrodes. Special machines. The resistance welding of light alloys. Types of machines for light alloys.

Projection Welding Practice, by R. W. Ayers. (*The Welding Industry, June, 1940, Vol. VIII, No. 5, p. 133, 11 figs*).

Projection welding is, in reality, a development of spot welding, with this difference. In spot welding the size and position of the weld is determined by the size of the electrode points and where they are applied to the work pieces, whereas in projection welding the size and position of the weld, or welds, is determined in the design of the components to be welded and projections are raised on the workpieces to form the welded zones. Physical conditions. Practical illustrations : Multiple projection welding of hinge to door panel, of forged handle to tray, of hoop and reinforcing plate to steel barrel with projections formed on the body of the barrrel, of studs and bolts to a sheet metal construction. Welding of nuts, etc., to chassis frame, tanks, etc. A petrol right joint is produced by the welding of the filler cap reinforcement. The Sciaky machine type PM.2P, incorporating 2 or 3 pressure cycle.

INDEX TO ADVERTISEMENTS

Research Department: Production Engineering Abstracts

(Edited by the Director of Research)

ANNEALING, CASEHARDENING, TEMPERING.

Casehardening, by Metallurgist. (*Mechanical World, July 19, 1940, Vol. CVIII, No. 2794, p. 41, 4 figs.*).

Practical processes. Cyanide process. Influence of carburising temperature and time on depth of penetration using a low energy carburiser. Steel casehardening.

Heat Treatment of Carburised Work, by Metallurgist. (*Mechanical World, July 26, 1940, Vol. CVIII, No. 2795, p. 62, 2 figs.*).

The carburising temperature should be as low as possible consistent with being above the upper critical point of the steel. For a plain carbon steel with about 0.15% carbon, this point lies about 800°C. For general work good commercial practice appears to be in the neighbourhood of 890°-920° C. Special nitriding furnace. The furnace is movable to allow continuous operations. High carbon (0.85%) bar. Cross-section showing surface decarburised after rolling and same bar recarburised by cyaniding. The nitriding process depends on the absorption of nitrogen into the steel. In this case special steels are used, the principal requirements being the presence of some or all the following elements in the steel : aluminium, chromium, molybdenum and sometimes vanadium. Contrary to the carburising practice, the initial steel may be quite high in carbon content thus allowing a strong core to be obtained. The usual programme is to quench the steel in oil from 900°C. and, when cold, to draw at about 680°C.

Nitriding Steels, by H. H. Jackson. (*Aircraft Production, July, 1940, Vol. II, No. 7, p. 220, 11 figs.*).

Difficulties encountered in practice ; need for strict control of materials and processes. Determination of the causes of defects in nitrided parts. Lacunae in a nitride case, revealed after honing and lapping hardening surface. Disintegration of case due to linking of minor local failures. One of the most frequent causes of early service failure is the presence of non-metallic inclusion in or adjoining the nitride layer. A chemically clear, bright surface is essential for uniform hardening, and the importance of thoroughly cleaning parts immediately before packing cannot be over-emphasised. Depth-hardness curves for nitrided chromium-aluminium steel (DTD 87), nitrided chrome-molybdenum steel (DTD 306) and carburised mild steel (S 14). Nitriding forgings. Nitriding is of greatest value when applied to parts subject to sliding friction. The designer sometimes specifies a nitriding steel for a component where a carburised or cyanide-hardened material will suffice.

COMBUSTION, FURNACES.

Furnaces for Heat Treatment, by Metallurgist. (*Mechanical World, July 5, 1940, Vol. CVIII, No. 2792, p. 1, 5 figs.*).

Furnace selection—gas and electric firing—tempering furnaces—conditioned atmospheres—pyrometric control—quenching liquids. Essential factors :

(a) Cost of fuel (or electric power). (b) Ease in maintaining uniform temperature in the furnace load. (c) Ease of control of temperature. (d) Chemical nature of the furnace atmosphere and its influence on the work. (e) Labour required to work the furnace. (f) Nature of the operations themselves (continuous or intermittent). (g) Relative costs of repairs and general maintenance. Cross-section of large furnace used for heat-treating forgings and other large work, Recuperative radiant tube furnace installation. Electric furnaces. Tempering furnaces.

COOLANT, LUBRICANT

Cutting Fluids. (*Automobile Engineer, June, 1940, Vol. XXX, No. 398, p. 175*).

Of the many factors involved in machining operations, none is perhaps so little understood by the production engineer as the part played by the cutting fluid. Influence on : overall cost, surface finish, tool life. Cutting fluids and carbide-tipped tools. Recent research on applications to machining operations. American practice in use of cutting fluids for various metals and operations. Comparative dilution ratios for milky emulsions and clear soluble oils for various operations and materials. Soluble oils. Neat cutting oils. Cutting fluids and skin diseases.

FOUNDRY, MOULDING.

Machine Tool Castings, by F. J. Dost. (*Mechanical World, June, 14 1940, Vol. CVII, No. 2789, p. 523, 2 figs.*).

How examination of the surfaces of long-service lathes revealed desirable qualities for new materials. For more uniform castings better finish,, and greater wear resistance, the high-strength type of iron was adopted. This iron consisted of mixtures having 70-95% steel content with low carbon and high silicon—just opposite to the semi-steel conditions. The scoring or galling of the wearing surfaces or ways. Photomicrographs of specimen in which flake graphite formation has been induced. Results of wear tests giving weight loss per hour. The ultimate aim is to be able to establish conditions which will completely eliminate or minimise the formation of primary ferrite. If all primary ferrite is removed in the machining operation, we have a normal structure at the wearing surface.

Volume Changes in Lathe Beds, etc., During Cooling Down, by E. Longden. (*The Machinist, June 29, 1940, Vol. 84, No. 19, p. 220E, 2 figs.*).

Contraction in cast iron. Shrinkage. Factors influencing contraction include : (1) chemical composition of the alloy ; (2) melting conditions, pouring temperature and superheat of the metal ; (3) design, section and volume related to section ; (4) size, shape, location and distribution of runner and riser gates ; (5) character of the mould and core materials and their condition when the metal is poured into the mould ; and (6) method of moulding and coremaking. Method used for ascertaining volume changes of a lathe bed. Test procedure. Tests on large solid boring bar casting.

GEARS, GEARING

The Effect of Centring a Hob Tooth of Space when Cutting Spur and Spiral Gears, by H. Walker. (*Machinery, June 6, 1940, Vol. 56, No. 1443, p. 289, 9 figs.*).

The effect of centralizing the hob and to determine what differences in results, if any, are obtained thereby. Typical centring fixture for a hobbing machine. Stages in the generation of a tooth profile by means of a hob.

Diagram showing symmetrical points of contact on the profile when a hob tooth or space is centred. Diagram illustrating the calculation of profile error caused by " flats " on the profiles. Method of plotting profile errors using the line of action as a base. Profile errors in 18-tooth gears, cut with single thread hob having 12 gashes. One gear cut with the hob centred and the other with the hob offset. Profile errors in 16-tooth gears cut with a double thread hob having only six gashes. One gear was cut with the hob centred, and one with the hob offset by a maximum amount. The " flats " on the profiles show up as measurable errors. Failure to centre the hob tooth or space does not affect the accuracy of the involute part of the tooth profile. It merely distributes the flats of which the profiles are built up, in a non-symmetrical arrangement on each side of the tooth.

HEAT, HEAT ECONOMY.

The Application of Electric Heat, by E. Covington. (*Journal of the Institution of Heating and Ventilating Engineers, June, 1940, Vol. 8, No. 88, p. 142*).

It has been proved in many cases by a straight comparison of fuel costs, together with labour charges and maintenance, that the use of electric heat has been cheaper than that provided by the fuel which electricity replaced. The following items, however, have to be observed : (a) Space occupied by plant and fuel. (b) The safety and convenience of the particular system. (c) Maintenance of heating apparatus. (d) Ease with which fuel can be handled. (e) Labour charges. (f) Cleanliness. (g) The psychological effect which the particular method of heating may have on the health and comfort of the users. (h) Smoke abatement. (i) Variations in cost of fuel. (j) The flexibility of the particular system. When two methods of applying heat exist, it is necessary for the heating engineer to decide which method he proposes to adopt, and to do this he must investigate the requirements of the particular job. There are four main types of direct electrical heating equipment, and these are :—(1) Those designed for heat emission by radiation. (2) Those whose heat output is essentially by convection. (3) Simple air heaters. (4) Those whose heating effect is by both radiation and convection. Their advantages and disadvantages are discussed.

KINEMATICS.

Kinematic Synthesis of Mechanisms, by A. E. R. de Jonge. (*Mechanical Engineering, July, 1940, Vol. 62, No. 7, p. 537, 47 figs.*).

A new terminology to replace Reuleaux's fundamental work. Intermittors are subdivided into six subclasses, grouped in two groups of three subclasses each: (A) Devices which make motion of the blocked piece temporarily impossible, or statomotors. (B) Devices which let motion of the blocked piece temporarily occur, or motostators. The subclasses are easily recognisable as the term " gear " has been added to the characterizing term. Types of release gear analyzed. Use of screw trains. Use of crank trains or linkages. Use of wheel trains. Use of cam trains. Use of fluid trains. Value of kinematic synthesis and branches of this science.

MACHINING WITHOUT CHIPS.

The Extrusion Process of Valve Production. (*Machinery, July 4, 1940, Vol. 54, No. 1447, p. 438, 5 figs.*).

The extrusion process adopted by Daniel Doncaster and Sons, Ltd., who incidentally also produce hand-forged and electrically-upset valves, appears to provide a method for rapid production of high duty valves by semi-skilled labour. For this process the press is set up with extrusion and finishing

dies side by side. Illustrations show slug, extruded and finished valves; extrusion die and finishing die. Each operation is completed in one second.

The pressure exerted by the dies during extrusion is in effect a squeezing process which knits together the structure of the metal in distinct contrast to the bursting effect of the electric upsetting process.

MANUFACTURING METHODS.

Stack Cutting as an Aid to Mass Production. (*Industrial Gases, June, 1940, Vol. 21, No. 2, p. 78, 9 figs.*).

Stack cutting is chiefly used in automobile and similar work. The chief purpose is the cutting of blanks for small precision parts. It is possible in many instances to work direct to a templet and carry out folding, drilling, or similar operations immediately after the cutting process. An investigation was made into the time saved by using stack cutting for the preparation of small parts. Results show relations of 1 : 20 up to 1 : 30. In each case the cutting speed was 38 in. per hour and the oxygen pressure 48 lb. per sq. in,

Machining Breech Rings and Breech Blocks for Anti-aircraft Guns. (*Machchinery, July 11, 1940, Vol. 56, No. 1448, p. 153, 15 figs.*).

Methods employed in the production of the Bofors 40 mm. gun at a Royal Ordnance Factory. The breech-ring forging at various stages in the sequence of machining operations. The rough forging from which four breech rings are machined. The forging after the preliminary planing and boring operations. Views showing where milling operations are performed on the breech-ring forging. The operations involved in machining the bore for the gun barrel. The breech-block forging, showing the firing-pin hole. The breech-block forging showing the trigger lever and catch-pin holes.

The Ekko Process for Making Iron Dies. (*Machinery, July 18, 1940, Vol. 56, No. 1449, p. 486, 3 figs.*).

By the new process the moulds and dies are produced by the "electroforming" of iron against a pattern. Electroforming is simply a type of electroplating process, and differs only in so far as deposits up to ¼ in. thick can be made. Illustrations show a radio dial and its mould made by the electroforming process; a die and a "force" made by the electro-forming process from a plastic pattern. Patterns on which the iron is deposited may be wood, glass or plastics, provided the surface is made to conduct the current. Dies for a sweet dish made by the electro-forming process.

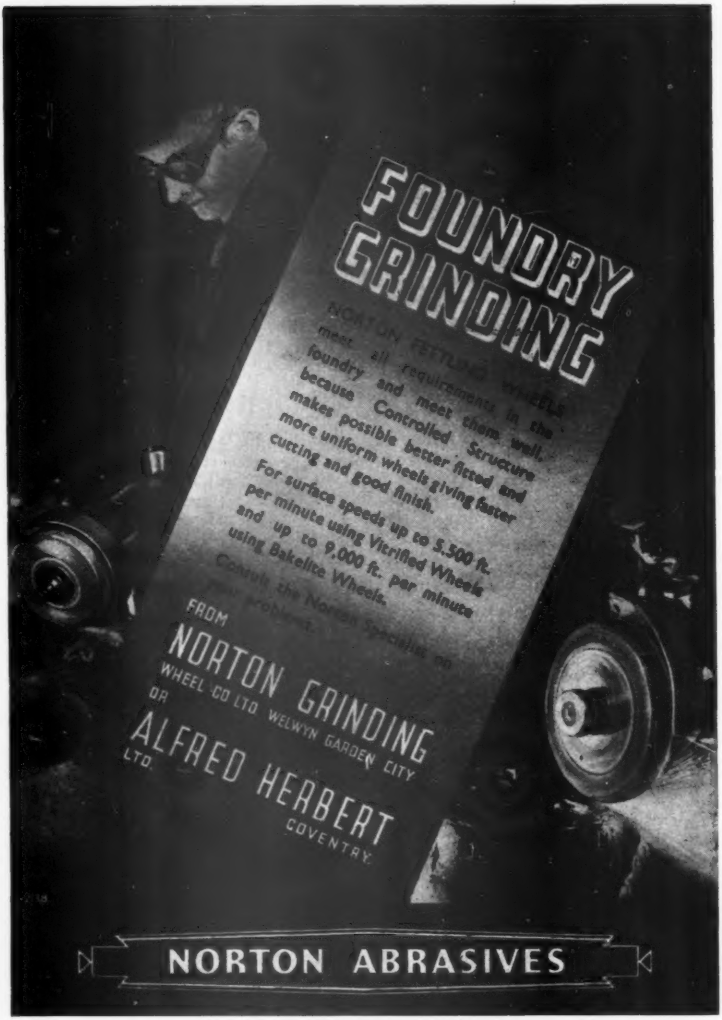
MATERIALS, MATERIAL TESTING.

Magnesium for Aircraft Construction, by E. W. Conlon. (*J. Aeron. Sci., U.S.A., Vol. 7, No. 6, April, 1940, pp. 252-5*).

The present status of magnesium as a material for aircraft construction is similar to that of aluminium in about 1922, and the material is going through the same stages of development. Of the new alloys that are constantly being introduced, the designer should consider only those rated A or B by the producer, as regards corrosion resistance, and alloys with low elongation as compared with aluminium alloys should be avoided.

Static tests referred to in this paper prove that magnesium alloys are satisfactory from a strength-weight standpoint, although much research must be done to determine the most efficient forms, particularly extrusion and corrugation.

Full-scale static and service tests on wings, fuselages, or tail surfaces must be made to definitely prove that the material and method of surface protection are satisfactory under actual service conditions.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The practice of some manufacturers to use magnesium alloy sheet for fairings and cowlings appears to be a hard way of learning how to fabricate the material. These parts are difficult to form in any material, and strength is a minor consideration. It would seem more practical to first use magnesium sheet where little forming is required and where the high buckling strength is important, such as the covering of a wing or fuselage.

It appears to the author that the stamped butt-welded or cast wing and fuselage may offer as much possibility for low-cost quantity production as any of the various plastics which have recently been suggested.
(Communicated by D.S.R., Ministry of Aircraft Production).

Delayed Age-Hardening, by J. C. Arrowsmith and K. J. B. Wolfe. (*Aircraft Production, July, 1940, Vol. II, No. 7, p. 225, 3 figs.*).

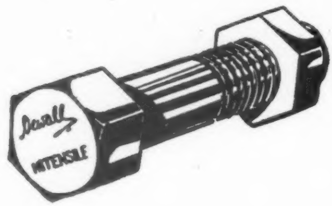
Investigations into the use of refrigeration to speed-up the production of large duralumin aircraft pressings. Limitations of heat-treatment. Influence of temperature on rate of age-hardening. Compositions of materials. Constituents: copper, manganese, magnesium, silicon, iron. Effect of decreasing the temperature. Time-hardness relationship during the first 200 hours of age-hardening. The temperature at which the pieces A, B, C, D, E, were aged is as follows: A at 22 deg. C., B at 0 deg. C., C at —6 deg. C., D at —11 deg. C., and E at —18 deg. C. Practical applications. Details of construction of a refrigerated store for duralumin blanks were next considered. Experiments were carried out to determine the time taken by blanks to cool to the air temperature in a refrigerator.

The Damping Capacity of Metals, by W. E. Bardgett. (*Mechanical World, June 21, 1940, Vol. CVII, No. 2790, p. 548, 4 figs.*).

The property of damping, which is a specific property of materials, has in certain cases a profound effect on the behaviour of material in service. The free vibration method is the test most commonly used. Two forms of equipment, based on this method, are in most general use, the Foeppl-Pertz and the Cambridge Instrument Company's type, the latter shown being widely adopted in this country. Typical disc record. Curve of free oscillation. Percentage damping ratio in relation to surface shear strain. Damping capacity may vary with the number of stress alterations; consequently the initial damping of materials may undergo a change when a material is subjected to stress alterations in service.

The Detection of Defects in Magnetic Materials by Magnetic Methods, by A. M. Armour. (*Machinery Lloyd, July 13, 1940, Vol. XII, No. 14, p. 21, 13 figs.*).

The magnetic methods depend on the fact that, in magnetic material the magnetic susceptibility of a fault is markedly inferior to that of the surrounding material. A crack, blow hole, or slag inclusion acts as an air gap or discontinuity in the path of magnetic flux causing to flow in the material in such a direction that it crosses the principal plane of the defect substantially at right angles. The defect or discontinuity lying across the path of the magnetic flux causes the flux to bend round the fault, seeking an alternative path in the material surrounding it. Electromagnetic methods. Magnetic needle method. Magnetic powder method. Diagram illustrating one method of crack detection. Portable magnetic crack detector locating cracks in article placed beneath. Electroflux magnetiser. Portable fluid detector. Rod before and after being tested for longitudinal cracks. Aero engine gudgeon pin being tested in magnetiser giving a "roving spiral" resultant field. Welds tested by the magnetic fluid method. Electroflux crack detector for spring testing. Faulty spring tested by method described. Magnetic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writing. Density of magnetic fluid. Types of magnetising machines. Transportable crack detector equipment. Demagnetisation. Although the principles involved in magnetic crack detection are simple, and the machines have been made semi-automatic in a number of cases, much depends upon the inspector who uses the equipment.

The Working of Magnesium Alloys. (*The Machinist, June 29, 1940, Vol. 84, No. 19, p. 291, 10 figs.*).

Physical constants of pure magnesium. Alloying elements. Index to specifications for magnesium-base alloys. Weights of structural metals. Forgings and extrusions. Design hints. Physical characteristics of typical cast and wrought magnesium-base alloys. Shop practice for magnesium. Machinability of cast metals. Turning and planing. Milling. Drilling. Reaming. Threading. Tapping. Coolants. Filing. Sawing. Distortion. Fire prevention. Sheet working methods. Bending and forming. Pressing and drawing. Spinning. Riveting practice for magnesium. Gas welding. Buckling and cracking. Weld cleaning. Resistance welding. Soldering. Cleaning. Chemical coloring. Primers and paints.

The Influence of Crystal Size on the Wear Properties of a High-Lead Bearing Metal, by J. R. Connelly. (*Trans. A.S.M.e., U.S.A., Vol. 62, No. 4, May, 1940, pp. 309-18*).

A specimen of bearing material has one side machined to a plane surface. A constant holding force, hereafter referred to as the load, presses the machined surface tangent to a rotating steel cylinder, submerged in a bath of lubricant. For these tests the force was obtained by gravity. The specimen, which can move only in a direction normal to the machined surface, wears a cylindrical groove and the contact changes from line to a progressively larger area. This wearing away continues until equilibrium conditions are established between the forces causing wear and the forces resisting wear. The load divided by the projected area at any instant is referred to as the pressure and the pressure existing at equilibrium is called the final or ultimate bearing pressure or equilibrium pressure. Rate of wear is designated as volume of bearing material removed per length of travel of a point on the surface of the cylinder.

Conclusions.—The results are evidence that, for the bearing metal tested, (a) crystalline structure is a factor and crystal size an important variable in thin-film lubrication, (b) rate of wear and equilibrium pressure are related, and (c) pressure at beginning and end of lubricated wear are related. The method of investigation used is a way of determining qualtitative values of rate of wear, equilibrium pressure, and the pressure at the borderline condition between unlubricated wear and lubricated wear. Other things being equal a very small cylinder size gives optimum values of rate of wear and equilibrium pressure.

Bearings that are poured in place, such as large pillow-block bearings, have crystal sizes in the range where the rate of wear and equilibrium pressure are decidedly not otpimum. In the future, such large bearings could be better designed to make use of some type of insert that could be cooled rapidly upon pouring.

(Communicated by D.S.R., Ministry of Aircraft Production).

A Rational Definition of Yield Strength, by W. R. Osgood. (*J. App. Mech., U.S.A., Vol. 7, No. 2, June, 1940, pp. 61-2*).

Explicitly or implicitly the yield strength of a material is often used as a measure of incipient structural damage. With the yield strength determined by conventional methods, however, it cannot be said in general for two structural elements geometrically alike but of different materials that similar loads, producing maximum stresses equal to the yield strengths in the two

cases, are simply related to the yield strengths. A definition of yield strength is proposed in this paper which often has the advantage that, for geometrically similar structures of different materials, loads producing maximum stresses equal to the yield strength are proportional to the yield strength.

The Effect of Rest Periods on the Endurance and Fatigue Strength of Metals, by F. Bollenrath and H. Correlins. (*Z.V.D.I., Germany, Vol. 84, No. 18, May 4, 1940, pp. 295-299*).

It is known that the type of load variation occurring in actual practice plays an important part in the endurance and fatigue strength of engineering materials. Laboratory tests should therefore imitate as closely as possible practical conditions. Of special interest is the resistance to oscillating loads well above the fatigue limit, provided such loads only occur at infrequent intervals during the design life. In this connection, the possible effect of rest periods (*i.e.*, periods of time during which the material is free from load), on its endurance become of importance. The author investigated a number of Al, Mg, Fe and Cu alloys utilising a hydraulic pulsator operating at 1,000 stress cycles per minute (variable tension). During each cycle the stress varied between a fixed lower limit (usually 5-7 Kg/mm^2) and an upper limit, which was either maintained constant till the specimen failed (normal Wohler curve) or rest periods (varying from 6-18 hours) were interposed after a definite number of load cycles during the test.

The results show that for the materials examined, the two Wohler curves are in agreement within the limits of experimental error. The number of load cycles required to produce fracture with a stress cycle of a given amplitude is thus unaffected by rest periods during the test.

(Communicated by D.S.R., Ministry of Aircraft Production).

MEASURING METHODS, APPARATUS.

Automatic Inspection of Crankshafts. (*Machinery, July 25, 1940, Vol. 56, No. 1450, p. 509, 6 figs.*).

A completely automatic machine performs fifty different inspection operations on each crankshaft and indicates why rejected crankshafts fail to meet requirements. Diagram mounted over the discharging end of the inspection machine to indicate to the inspector the meaning of the ink marks on any rejected crankshaft.

Evaluating the Surface Finish of Metals, by J. Guild. (*Engineering, July 19, 1940, Vol. 150, No. 3888, p. 44, 3 figs.*).

Instrument designed by Mr. F. Guild, of the N.P.L., for assigning numerical values to the surface finish of metals. The first model is intended for the examination of approximately flat surfaces, such as rolled metal sheets. Light is reflected in a particular direction, as by a mirror, and some is scattered; the smoother the surface the greater is the first or specularly reflected part, and the less the second or scattered part. The instrument is used to compare these two portions using a photo-electric cell. To establish a scale of surface finish two reference standards are employed ; a perfectly diffusing surface of magnesium oxide, *i.e.*, a perfectly mat surface, gives the zero point of the scale ; and a perfectly polished surface of thin optical glass silvered on the back is assigned the value unity. A single determination, including the calculation of the result takes less than a minute. Some typical results given in a table show the positions on the smoothness scale of a number of familiar types of surface finish.

MECHANICS, MATHEMATICS.

The Construction of the Cone-Cylinder Joint, by W. Sellar. (*Mechanical World, July 26, 1940, Vol. CVIII, No. 2795, p. 59, 16 figs.*).

A geometric principle which gives precision to the layout of welded pipe junctions. Penetration of cone by cylinder. Cone and cylinder junctions. Examples of junctions to meet practical conditions. Small branch taken off a large pipe. Branch entering a large pipe at an angle. Geometry of basic circle of cone and cylinder joint.

PHOTOGRAPHY, X-RAYS, MOVING PICTURES, ETC.

High-Speed Photography and the Study of Rapid Machine Motions, by V. Sepavich and A. Palmer. (*Mechanical Engineering, July, 1940, Vol. 62, No. 7, p. 519, 7 figs.*).

For analytical purposes, mechanisms may be classified in three groups from the standpoint of the means by which they are driven or controlled : First, those that are positively connected with the source of power ; second, those that are driven in a semi-positive manner ; and third, those that, at some point in their cycle of operation, are freely moving bodies. Types of problems involved. Problems dealing with positively controlled motion can be solved by the theories of mechanics. They can be analysed by graphical and mathematical processes. Physical tests can be made through the use of models or actual machines. Generally speaking, by a combination of these processes, difficulties with machine operation can be overcome. Photographic means available. Shuttle photographed by high-grade still camera. View of shuttle taken with aid of stroboscope. Experience with the various forms of photographic equipment has shown that the Edgerton power stroboscope is particularly valuable in the development of textile machinery. Shuttle " caught" at start of travel across loom. Bobbin in process of being transferred in loom at approximately 172 r.p.m. Another typical example of use of high-speed photography in studying loom operations. Stoboscopic slow-motion pictures.

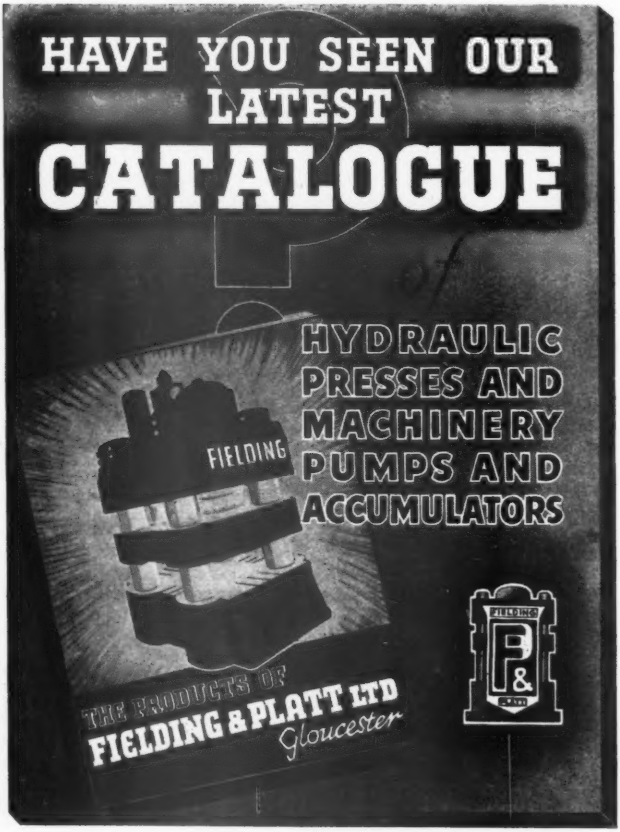
SMALL TOOLS.

Die Design and Construction, by C. R. C. (*Machinery, July 18, 1940 Vol. 56, No. 1449, p. 489, 10 figs.*).

The article deals with piercing, cutting-off, and forming dies. A piercing cutting-off and forming die of the slug type. Shear type with a trimming die at the forming station. Shear type of die for a blank having similar, or nearly similar ends. Diagrams showing dies designed for angle-forming operations. Tools for cutting-off and forming operations with forming die machined to a steeper angle than the punch. Die designed for ejection of work by compressed air. Forming die with punch equipped with positive knock-out. Die with spring pad for raising the work to the top of the cutting-off die. Die with spring knock-out pins. Lift-out type of knock-out incorporated in a cutting-off and forming die. Die equipped with a trigger type end gauge.

Increasing the Life of Cutting Tools by an Improved Method of Grinding, by L. J. C. (*Machinery, July 4, 1940, Vol. 56, No. 1447, p. 431*).

The new method of grinding and polishing high-speed steel and Stellite tools involves : 1. The maintenance of proper clearance and rake angles through quadrant control. 2. The rough-grinding of the tools in such a way as to eliminate burning or checking. 3. The polishing of clearance and top rake angles, so as to eliminate the coarse cutting edge produced by the grinding wheel and the rough surface on the top face of the cutting tool which causes excessive frictional heat as the flowing chip slides over it. Marked increase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in the life of polished tools. It is important that grinding or polishing marks should be parallel to the chip flow. Grinding and diamond-lapping of cemented-carbide tools. Control of clearance and rake angles. In the new method outlined, the use of the diamond lap as a means of securing a strong, unbroken cutting edge on carbide tools is recommmended.

SURFACE TREATMENT.

Superfinishing, by E. L. Hemingway. (*Aircraft Engineering, July, 1940, Vol. XII, No. 137, p. 216, 3 figs.*).

What is desirable in a bearing surface ! The surface of a cylindrical part would be absolutely round and smooth, in perfect alignment with the mating surface and with the minimum of clearance compatible with proper lubrication. Deficiencies of common finishes. The evaluation of surface quality. Chrysler's " Superfinish." Different applications of superfinish. Equipment for superfinishing Control of superfinishing conditions. 1. Type of stone selected. 2. R.p.m. or surface footage of the part. 3. Kind of stone lubricant used. 4. Spring pressure used. 5. Traverse per revolution. 6. Oscillation speed. 7. Quality of surface prior to Superfinish. Experiences in sample finishing. The stock removal will be no more than one tenth of a thousandth. Together with superfinish, we shall produce parts which will assemble into mechanisms with smaller clearances maintained over much longer periods of time.

A Revolution in Pickling Methods, by Alastair McLeod. (*Sheet Metal Industries, July, 1940, Vol. 14, No. 159, p. 715, 6 figs.*).

The chemical and mechanical details of the de Lattre combined pickling and regenerative process. The pickling action. Pickling solutions. Pickling bath of the style patented by de Lattre. Details of the dipper and agitator mechanisms are also shown. Regenerating hydrochloric acid solutions. The mechanical details of the dipping and agitating gear for tinplates, sheets an and steel strip are depicted. Some of the advantages afforded by this pickling method may be briefly summarised as :—(1) Increased speed, due to control of liquid acid density and temperature. (2) Thorough cleaning of the metal surface. (3) Reduction of hydrogen absorption and consequent brittleness due to incorrect pickling operations. (4) Complete preparation of the pickled surface for the subsequent treatment, either for cold rolling or for metallic coating. (5) Ease of the complete recovery of the used pickling solution in specially designed apparatus. (6) The special pickling technique, combined with the recovery method, leads to an absolute minimum of acid consumption, and to a correspondingly reduced loss of iron. (7) Reduced steam consumption for heating baths owing to lower working temperature required. Two views of a standard type of regeneration plant at Sclessin and Flemalle (Belgium). Ferrous sulphate and waste disposal. Manufacture of sulphuric acid. Plan and elevation of the complete pickling and regenerative installation at the works of Phoenix Steel Sheet and Tinplate Co., Ltd., Liége.

Metal Spraying by the Wire Process, by W. E. Ballard. (*Sheet Metal Industries, July, 1940, Vol. 14, No. 159, p. 747, 9 figs.*).

The pistol needs 4 feeds. These are :—(1) The metal in the form of round wire from 1 to 2 mm. in diameter. (2) A combustible gas of minimum calorific power of 450 B.T.U. and at a pressure of 20 to 30 lb. per sq. in. Coal gas compressed on site, or coal gas. Hydrogen and dissolved acetylene used from cylinders. (3) Oxygen used from cylinders fitted with multistage regulators. (4) Compressed air at from 40 to 60 lb. per sq. in. pressure and at a volume equivalent to 14 to 20 cub. ft. of free air per min. Latest type of British

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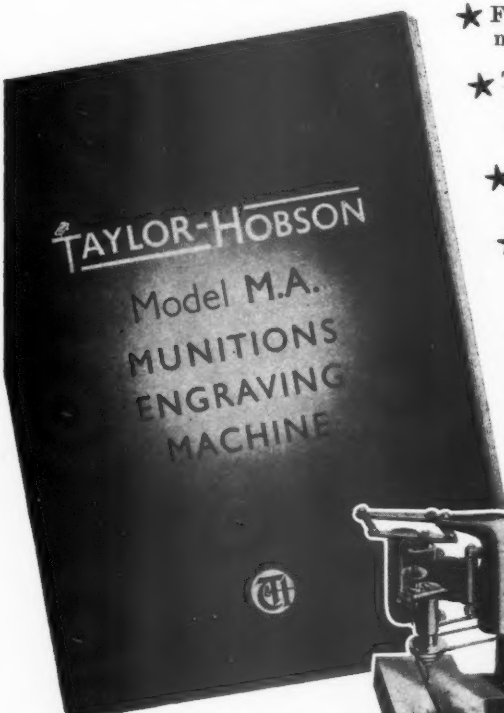

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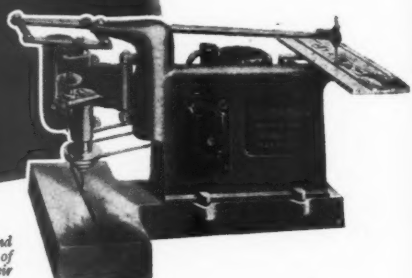

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metal spraying pistol with side panel removed to show turbine. The consideration of metal spraying as a finish for metallic or certain classes of non metallic articles. In practice, the minimum thickness of metal applied by metal spraying commercially is 0.002 in. and usually the thickness is 0.004 in. or over. The surface to be sprayed must be clean and free from grease, and must also be suitably roughened. In practice the method always used for cleaning and roughening the surface is that of shot-blasting with angular steel grit or an aluminous abrasive such as "Blastyte." The particle size (which on an average is .01 mm. diameter) will vary with melting-point of the wire used. The colour of sprayed metal is that of the virgin metal. Sprayed coatings can be polished to a very high finish by the usual mops and polishing compound. It should be noted that chromium cannot be sprayed as chromium wire cannot be obtained commercially.

WELDING, BRAZING.

Tentative Standard Methods for Mechanical Testing of Welds. (*Welding Journal, March, 1940, p. 201, 19 figs.*).

These standards have been prepared by the Committee on Standard Tests for Welds of the American Welding Society. The report deals with the weld metal, butt welds and fillet welds. Weld metal is to be tested by its density, soundness as shown by an etch test, and its tensile strength ; butt welded joints by a nick-bend test, a guided-bend test, tensile strength and ductility ; fillet welded joints by a weld-break test, and shearing strength in transverse and longitudinal directions. The report gives dimensioned diagrams of the specimens and procedure and explains the units and significance of the results obtained from such tests.
(Communicated by D.S.R., Ministry of Aircraft Production).

Shaping Edges for Welding, by H. E. Rockefeller. (*Steel, March 11, 1940, p. 60, 11 figs.*).

The article is concerned with the preparation of edges before welding, and explains how single nozzle oxy-acetylene torches may be made to give full "U" or "J" grooves in a single pass. It explains a plate-riding device, the use of which allows the proportions of the grooves to be varied, and it proceeds to discuss the simultaneous use of two or more nozzles. The positioning of the plates to be cut is important, and the merits of differemt methods of setting up are discussed.

Bi-Metal Foils for Brazing Hard Alloy Tips on Tools. (*Z.V.D.I., Germany, Vol. 84, No. 18, May 4, 1940, pp. 310-311*).

The usual method of brazing hard alloy tips on to the body of the tool may lead to cavities existing between the tip and the tool shaft which may cause the tip becoming unstuck or even fracturing. This difficulty is overcome by making use of special copper-steel foil, consisting of small grooved steel plates covered with silver solder and embedded in a copper solder. This foil is placed in the cut-out portion of the tool, the tip placed in position and the whole heated in a muffle furnace to the requisite temperature. Details of the subsequent treatment are given and it is stated that perfect adhesion can be ensured for tips of not more than 3-4 mm. thickness.
(Communicated by D.S.R., Ministry of Aircraft Production).

Welding Aluminium Alloys. (*Aircraft Production, July, 1940, Vol. II, No. 7, p. 234, 3 figs.*).

The new Taylor-Winfield aircraft welding machine. The adjustable cylinder and retractable head of the Hi-Wave spot-welder. Arrangement of the Hi-Wave circuit.

INDEX TO ADVERTISEMENTS

Research Department: Production Engineering Abstracts

(Edited by the Director of Research)

ANNEALING, CASE-HARDENING, TEMPERING.

Hardenability and Quenching, by M. A. Grossmann and M. Asimow. (*Iron Age, 1940, Vol. 145, April 25, p. 25*; *May 2, p. 39*).

A method developed for standardising the severity of quenching applied to steels, and for ascertaining the degree of quenching to which a steel has been subjected. A chart by which such determination can be made is reproduced. The method is based on determination of the ratio Du/D, where Du is the diameter of the unhardened core of a test piece after quenching, and D is the diameter of the bar.

ACCOUNTING, ADMINISTRATION.

"Feelings" and Production Costs, by Walter Dietz. (*Production Series, No. 124, American Management Association, p. 3*).

Most managements believe in financial incentives but have not given thought to the feelings that make for loyalty and efficiency in employees. The illusions, that sometimes cause management to overlook the feelings of employees, are : 1. That people always reason things out before they make a decision or take action. 2. That the one infallible motive to which individuals respond at all times and under all conditions is economic gain. 3. That workers who really know their jobs and want to work are not affected by how others feel about their work. 4. That if you begin to pay attention to how people feel you are letting yourself in for an awful lot of trouble. Indirect production losses. The cost of injured feelings. When its reasonable to be unreasonable. When pride's hurt, production fails. Make them see the product in use. Leadership from the top. The introduction of change. Try to understand.

How to Organise a Supervisory Program for Cost Reduction, by R. B. Davenport. (*Production Series, No. 123, American Management Association, p. 14*).

Resistance to new ideas. Resentment of criticism. How to win the support of top management. Organising the program. Individual problems are discussed. Aids in conducting a meeting. Projects should be handled quickly. Value of personal interview. Good Housekeeping program.

COOLANT, LUBRICANT.

Skin Troubles and Machine Tools, by A. Duckham. (*Machine-Tool Review, May-June, 1940, Vol. 28, No. 174, p. 103*).

Dermatitis. The skin. Causes of oil dermatitis. Preventive measures : Personal cleanliness, protection of the skin, replacement of natural skin grease lost through contact with lubricating oil, general hygiene, cleanliness of machines and coolants, selection of workers. Dermatitis among workers using aqueous solutions.

EMPLOYEES, WORKMEN, APPRENTICES.

The Foreman and Cost Reduction, by W. C. Zinck. (*Production Series, No. 123, American Management Association, p. 3*).

Upon the foremen will be the responsibility of continuously rolling the lawn to keep cost bumps down. The foreman needs help and Management must give it to him, because a factory is only as good as its foremen. Control of operation spoilage. Control of quality. Control of toolmaking scrap. Control of toolmaking costs. Toolmaking cost analysis. Control of cost of sales. The salesman in the selling division corresponds to the foreman in the manufacturing division—both must work on, with, and through people to achieve results.

GEARING.

Cross Gear-tooth Rounding, Pointing and Champfering Machines. (*Machinery, August 8, 1940, Vol. 56, No. 1452, p. 582, 6 figs.*).

External spur-gear tooth-rounding machine. View showing indexing finger lining up one tooth with V-block under the cutter. Section through cross universal master work fixture. Machine for pointing and champfering internal and external gear teeth using a hollow mill cutter. Diagram of cutting action. Cutting tooth-end chamfers on a cluster gear. Twin heads for pointing both ends of the teeth of a spiral gear simultaneously.

Worm Gear Manufacture—II, by Harry Walker. (*Machine Shop Magazine, August, 1940, p. 40, 6 figs.*).

The functions of the worm thread grinding process are : (a) To eliminate hardening distortion and to produce a worm of accurate lead and spacing. (b) To produce a smooth surface finish on the threads. (c) To produce an accurate shape of profile which will ensure correct meshing with the worm wheel. Machines employing a disc wheel. The action of the disc-wheel grinder. Machines employing cylindrical wheels. Using the flat face of the wheel. Comparison of the disc and cylindrical wheel grinders. Layout for using a cylindrical wheel. Close-up of cylindrical wheel. Worm thread shape. In the case of the involute thread form, this can be both ground and tested on a practical basis, using the plane disc wheel for grinding and a straight line motion for testing.

Pre-selective and Servo-operated Gear-change Mechanisms, Part I, by H. C. Town. (*Machinery, August 15, 1940, Vol. 56, No. 1453, p. 605, 11 figs.*).

The trend of modern development in regard to change-speed mechanisms. Views of a pre-selective self-changing gear box giving five speeds. Diagrams illustrating the action of the Herbert patent " preoptive " headstock mechanism. Archdale cam-operated pre-selective gear change mechanism. Pre-selective gear change mechanism controlled by stop-rods and sectors. Synchromesh arrangement for controlling double-gear engagement. Sectional view of the Wilson self-changing gear. Planetary pre-selective gear. Diagram showing the arrangement and connections of the Newton reversing planet drive. Chrysler planetary type gear box arranged for hydraulic operation. Diagram showing the Cotal system of electro-magnetic control for a machine tool drive.

Part II. (*Machinery, August 22, Vol. 56, No. 1454, p. 631, 8 figs.*).

Push-button gear changing system. Servo-operated speed changing devices. Diagram showing the transmission for each speed of the Maybach gear box. Hydraulic servo action. Sectional view of motor-car gear box

with hydraulic control of automatic speed changes. Hydraulic control of automatic speed changes. Hydraulic couplings and torque converters. Borg-Warner transmission unit comprising a fluid coupling and change-speed gear. Automatic clutch engaging mechanism.

JIGS AND FIXTURES.

Foolproof Fixtures, by E. D. Ball. (*Machinery, August 15, 1940, Vol. 56, No. 1453, p. 597, 6 figs.*).

Designing equipment for use by unskilled labour. The question of location : spigot or register in conjunction with an angular positioning pin or lug. Inserted segments or strips. Wiping action to remove swarf, etc., obtained by a circular scraper ring. Dust extractors adjacent to cutters and tools. Principles illustrated by a roller ring fixture. Fixture arranged for automatic locking of a wedge operated support. Sliding V-blocks Spring supports. Automatic lock for spring support. Preventing sins of omission. Clamping. Electrically operated toggle clamp for a welding fixture. Magnetic fixture for holding cups on a surface grinder. Safeguarding against tool breakage. Expanding mandrel for thin liners with rubber gripping members.

Aircraft Jig Design. (*Aircraft Production, September, 1940, Vol. II, No. 9, p. 277, 22 figs.*).

Jigs employed in the manufacture of the Blackburn Skua monoplane. An interesting feature of the equipment is the extensive use made of large cast iron members in the construction of certain assembly features in place of the more customary structural steel sections. Considerable forethought and attention have also been given to the question of accessability. Trunnion mountings are employed on many of the assembly jigs and those of rigid construction are of open-sided design.

Junkers Stretching-Press Technique. (*Aircraft Engineering, August, 1940, Vol. XII, No. 138, p. 251, 7 figs.*).

Sectional drawing of a hydraulic flattening mill. Adjustable straining ties at the longitudinal and transverse sides of the table, which are fitted with adjustable straining tongs. Wing-tip bends produced in accordance with the stretching method. Various stretching parts such as channels, parts for waste gas collectors, wing ribs, etc. Wooden profiles for sheet-metal forming by the stretching method.

MACHINE ELEMENTS.

Cheap, Quick and Sturdy Methods of Machine Fixing, by " Rova." (*Sheet Metal Industries, August, 1940, Vol. 14, No. 160, p. 855, 12 figs.*).

The problems that confront the engineer to-day when he is not only concerned with installing new plant but must keep all other machinery running. 1. Accuracy. 2. Permanency. 3. Freedom from vibration. 4. Adequate foundation. 5. The choice of suitable types and dimensions for foundation and holding-down bolts. 6. Economy factors. 7. The safety of the operative. The rawbolt. The bolt anchor. The bolt-projecting type. The loose-bolt type. Strength and dimensions of standard Rawlbolts. Results of tension tests of bolt anchors. Section showing bolt-projecting type set in concrete with collars. Applications.

Magnolia T. C. Heavy Duty Bearing Alloy. (*Mechanical World, August 2, 1940, Vol. CVIII, No. 2796, p. 81, 8 figs.*).

On many marine Diesel engines it has been found that the life of ordinary tin-base white metal bearings is very limited. The problem of cracking of the

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WITH this one machine a wide variety of standard sharpening operations can be performed. In addition, several specialized grinding operations can be handled with greater speed and economy than formerly, yet with no sacrifice of accuracy. Following of spiral leads, indexing, diameter size, blade profile, feed to wheel on tooth face grinding, diameter cutting clearance, relief clearance, wheel dressing, radial faces on high spirals, all these important sharpening factors are under positive mechanical control, and all mechanical movements of the machine can be duplicated to assure uniformity of work on any number of pieces. The machine is equally adaptable for sharpening hobs, all makes of reamers, and milling cutters. For details write to

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white metal bearing linings in shells has become more acute, especially in crosshead bearings. The T. C. alloy evolved was brought about by the addition of cadmium and nickel, these elements overcoming the tendency to fatigue cracking and giving improved physical properties combined with excellent bonding characteristics. Pouring temperature of 280°C. When the tinning and metalling is correctly carried out in a steel bearing, a bond of very high strength is obtained and there is no danger whatever of the metal becoming detached from the shell. Shear strength of the bond 4.98 tons per sq. in. A lining table for large castings. Metalling procedure.

MACHINING, MACHINE TOOLS.

Tooling of Multiple Spindle Automatics, by C. C. Stevens. (*Tool Engineer, June, 1940, Vol. IX, No. 2. p. 16, 6 figs.*).

The selection of a multiple spindle machine for most economical production involves (1) the experience and preferences of the operating group in view of maintaining uniformity of equipment and interchangeability of tool holders and attachments within reasonable limits; (2) the consideration of set-up time of one machine as compared with another; (3) tool clearance; (4) general accessibility; (5) chip disposal; (6) operator's skill and supervision requirements. Chucks. Use of auxiliaries. Lubricants. Rotating tool layout for Goss & DeLeeuw chucking machine. Tool setting for: (1) Cone automatics; (2) Greenles automatics; (3) Tooling for Bullard automatics; (4) New Britain; 8 spindle automatic chucks; (5) 6 spindle 1¼ in. Acme-Gridley.

Tools and Speeds for Machining Aluminium Alloys, by W. A. Dean. (*Metal Progress (U.S.A.), Vol. 37, No. 5, May, 1940, p. 553-558*).

Aluminium alloys can be classified under the following main headings: (*a*) Non-heat treated casting alloys; (*b*) heat-treated casting alloys; (*c*) heat-treated wrought alloys; (*d*) non-heat treated wrought alloys. Members of each of the above classes can be further sub-divided into types (I, II, III) depending on whether the machining qualities are "excellent," "good," or require special care. In a previous article by the same author (*Metal Progress, Vol. 37, No. 2, February, 1940, p. 169-173*) about 40 commercial alloys in general use in the U.S.A. are listed in this manner. Type I alloys belonging to class (*a*) have the finest machining properties. No lubricant or cooling is required and relatively small cutting angles can be employed. Type II alloys necessitate large rake and clearance for successful machining, the metal chips being removed by shear rather than by tearing. In the case of heat-treated casting or wrought alloys of type III the tool wear may become excessive unless cemented carbide tips are used. Particulars as to requisite tool dimensions for turning, milling and planing are given (clearance, cutting angles, and rake). The author also considers the operation of drilling, tapping and reaming. Data on cutting speeds are summarised in the following table.

CUTS, SPEEDS, AND FEEDS WHEN MACHINING ALUMINIUM ALLOYS

	Rough Machining			Finish Machining		
	Cut *Inches*	Speed *Feet per min.*	Feed *Inches*	Cut *Inches*	Speed *Feet per min.*	Feed *Inches*
Lathe Turning :						
Type I castings, not heat treated	0.25 (*a*)	500 to 900	0.020 to 0.030	0.002 to 0.010	Maximum.	0.002 to 0.010
All others ...	3/16	400 to 800	0.007 to 0.020	0.002 to 0.010	600 to 900	0.002 to 0.010
Milling :						
Type I castings not heat treated	0.25	400 to 600 (*b*) 500 to 700 (*c*)	5 to 15 (*e*)	0.010 to 0.020	500 to 700 (*b*) 500 to 700 (*c*)	10 to 25 (*e*)
Type I castings, heat treated ... Type II castings. Types I and II wrought alloys — heat treated.	0.25	Maximum (*d*) (for milling all alloys except type III).	4 to 10 (*e*)	0.010 to 0.020	Maximum (*d*) (for milling all alloys except type III).	5 to 15 (*e*)
Type III alloys	0.25	300 to 500 (*b*)	3 to 8 (*e*)	0.010 to 0.020	500 to 700 (*b*)	4 to 10 (*e*)
Boring :						
Light duty (1 in. to 2in.	3/32 (*a*)	Maximum (*f*)	0.010 to 0.020	0.010 to 0.020 (*a*)	Maximum (*f*)	0.001 to 0.005
Medium to heavy duty.	[illegible] (*a*)	600 to 1.000	0.007 to 0.015	0.010 to 0.020 (*a*)	600 to 1.000	0.001 to 0.003
Shaping :						
Heavy duty 36 in.	0.25	Maximum (*g*)	0.010 to 0.030	0.005 to 0.010	Maximum (*g*)	0.100 to 0.150
Planing	3/8	Maximum (*h*)	0.025 to 0.100	0.005 to 0.015	Maximum (*h*)	0.050 to 0.375

Notes. (*a*) Cut measured on radius. (*b*) For carbon steel tools. (*c*) For high speed steel tools. (*d*) For cemented carbide tools. (*e*) Travel of work. (*f*) Peripheral speed of tool is maximum of most machines. (*g*) Travel of ram. (*h*) Speed of table.

(*Communicated by D.S.R., Ministry of Aircraft Production*).

MACHINING WITHOUT CHIPS.

Dies for Producing a Spot-light Lamp, by M.J.C. (*Machinery, August 15, 1940, Vol. 56, No. 1453, p. 616, 5 figs.*).

Spot-light lamp with body consisting of two drawn-steel shells. Successive stages in forming the bullet-shaped rear part of the lamp. Successive stages in forming the front or lens-carrying part of the spot light lamp. Dies and rolling tool employed in the production of the steel shells.

MANUFACTURING METHODS.

The Production of Optical Flats. (*Machinery, August 22, 1940, Vol. 56, No. 1454, p. 625, 8 figs.*).

Methods employed at the factory of Optical Measuring Tools, Ltd. Optical flats are now regularly employed in up-to-date tool rooms for checking gauges, and permit of measuring distances in terms of the wave-length of a suitable monochromatic light by observation of the interference fringes produced. The surface accuracy is such that in an area of about 1 in. square the departure from perfect flatness is not more than 0.000002-5 in. The interference fringes indicate the surface conditions of the glass plate. Stages in the manufacture of optical flats from the quartz prism to the finished product are shown. Preliminary operation on the quartz crystal. Roughing discs for grinding quartz crystals and blanks. The time necessary for grinding each side of the

blank is usually between fifteen and thirty minutes. Finish grinding and smoothing operations.

Cutting-off Operations, by F.H. (*Mechanical World, August 16, 1940, Vol. CVIII, No. 2798, p. 117, 14 figs.*).

The parting off of finished pieces include (1) the stability and endurance of the tool, (2) prevention of overheating, (3) leaving the work end of a suitable shape to facilitate an easy and accurate start of the tool at the next cycle, (4) accuracy of finish. Flat-blade tools. Circular tools. Dual production. Cutting off very slender pieces. Angular cutting-off tool. Cutting-off by swing tool. Multiple parting. Transport from cutting-off stage. Cutting-off holders.

Piston Rings and Gudgeon Pins, by J. A. Oates. (*Aircraft Production, September, 1940, Vol. II, No. 9, p. 284, 21 figs.*).

A survey of production methods employed by Hepworth & Grandage, Ltd. A product of particular interest is the " Phormicast " piston ring each of which is individually cast and not merely cut from a long cast-iron cylinder or " pot." The battery of magnetic moulding machines used for cast piston rings. A stack of 84 rings after removal from the box. Projectors used to check the circularity of each ring. Special gauging apparatus for measuring the width of gap. Lapping and checking rings on a Newall machine. A furnace specially adapted for hardening gudgeon pins. Lathe fixture for facing and counter-boring the ends of the pin. Lathe fixture for drilling the eccentric hole. Fixture for holding the pin during reaming and tapping operations and fixture for milling the oil groove.

Aircraft Riveting, by H. S. Broom. (*Aircraft Production, August, 1940, Vol. II, No. 8, p. 256, 19 figs.*).

Riveting processes absorb a very large proportion of the man-hours required for the production of a complete aircraft and often present formidable problems even to experienced manufacturers. The author reviews the various types of machines and the different methods available and touches upon some of the points requiring attention for the attainment of successful results.

Flame Machining, by J. G. Magrath. (*The Machinist, August 17, 1940, Vol. 84, No. 26, p. 456. 9 figs.*).

With notable records in cutting and welding, the oxyacetylene torch turns to surface shaping. Plate edge preparation is one of the applications. Specimens, prepared in the early stages of flame machining, show the versatility of the process. Flame machining classification diagram. The several types of cuts are classified in their application and their tolerances. I Planing—(*a*) deseaming, (*b*) gouging, (*c*) hogging, (*d*) surface planing. II Milling. III Turning. IV Drilling—(*a*) rivets, (*b*) lance, (*c*) punching. Milling specimens were prepared by the oxyacetylene flame machining process. After edge preparation, the butted plates (heavy section) are shown partially welded in the U-groove. The initial root groove of a U-groove is flamed machined in a 2 in. plate employing a radiograph. Again using the radiograph the bevel cut down to the root groove is flame machined at 6 in. per minute. Two flame machined plates forming the complete U-groove are ready for welding by conventional methods.

MATERIALS, MATERIAL TESTING.

The Effect of Crystalline Structure on the Properties of Metals, by W. Boas. (*The Journal of the Institution of Engineers, Australia, May, 1940, Vol. 12, No. 5, p. 147, 5 igs.*).

The paper shows how a knowledge of metallic single crystals can help towards an understanding of the properties of metallic crystal aggregates and also that the effect of crystalline structure on the properties of metals is not of academic interest only. A crystal is defined as an ordered arrangement of atoms. The external shape of the specimen is of no importance whatever. The arrangement of the crystallites in the aggregate. X-ray photograph of copper. The calculation of properties of materials based on the properties of the crystals. Comparison of calculated and measured properties of polycrystalline materials. Examples of the anisotropic behaviour of polycrystalline materials. Anisotropy of plastic properties in cold rolled copper sheet. Deep drawn cups of aluminium. Ears due to preferred orientation. It has been shown that the behaviour of metals is that expected from the properties and the arrangement of the crystals in the aggregate. Preferred orientation as developed after all technical processes of working, casting, and annealing have generally a detrimental effect on the properties.

A New Method of Testing and Grading Fine Abrasives (with Discussion), by E. L. Hemingway. (*J.S.A.E., U.S.A., Vol. 47, No. 2, August, 1940, p. 332-41*).

When a stone of too great hardness is applied to a ground surface, its too-rigidly-held grits are not removed to dress and sharpen its face and the cutting action slows down much sooner than desired. When the stone used has too little bond strength its action on the hill peaks results in an extremely rapid removal of metal as the stone breaks down very fast. After describing various preliminary tests, it is revealed that a Rockwell hardness tester with a $\frac{1}{8}$ in. steel ball and a 60 kg. load finally was selected for grading superfinishing stones. A curve is included that indicates the proper stone to use in superfinishing a given hardness of steel under standard conditions. Such graphs have been used for five months with satisfactory results, and the former difficulties have practically disappeared. It is concluded that every user of fine-grit bonded abrasive, no matter what their application may be, has at his disposal in this method an accurate means of predetermining their cutting characteristics.

(*Communicated by D.S.R.,Ministry of Aircraft Production*).

Cast Iron Cylinder Bores (Microstructure, Composition, Hardness, and Wear) (digest), by E. K. Smith, *J.S.A.E., U.S.A., Vol. 47, No. 2, August, 1940, p. 28*).

In a summary of the effect of the various elements of cast iron on its microstructure when other variables are considered constant, it is brought out that silicon and carbon soften the iron, that magnanese aids in controlling the effect of sulphur, that high phosphorus content tends to make the iron brittle, but hard phosphide inclusions retard wear, that nickel sets as a graphitizer promoting machinability, that chromium forms stable carbons, and that molybdenum promotes strength. It is concluded that cast irons with normal flake graphite give the best wear, those with large amounts of ferrite give poor wear, irons with ferrite-fine graphite structure give the worst wear, and irons with excessively coarse graphite give porous bores. The paper concludes with a brief digest of current ideas on the causes and prevention of cylinder wear, including abrasion, corrosion, and structure.

(*Communicated by D.S.R., Ministry of Aircraft Production*).

A New High-temperature Alloy. (*Mech. Eng., U.S.A., Vol. 62, No. 8, August, 1940, p. 613-4*).

The Westinghouse research laboratories have produced a new alloy, containing only 7% iron, which is stronger than any known steel. It retains its strength at temperatures higher than 2,000°F. The alloy, which is the result of almost seven years of research work, is actually stronger at 1,100°F. than ordinary low-carbon steel is at room temperature. Stranger still it has a low damping coefficient, or in other words, it retains its elasticity at such elevated temperatures. Almost half of K-42 B, as it is known, is nickel and about a quarter is cobalt. Other components include chromium, titanium, and iron. Production of the metal on a commercial scale is known to be practical, but its first cost will be high, and its immediate uses are expected to be those of a special-purpose alloy for dies, valves, steam fittings and, possibly, turbine blades and other applications requiring temperature-resistant metals. It is reported that the new alloy " creeps " a great deal less than other metals in its class.

MEASURING METHODS, APPARATUS.

A New Heat Transfer Liquid for Temperatures up to 900°F. (*Mech. Eng., U.S.A., Vol. 62, No. 8, August, 1940, p. 613*).

A new chemical mixture used as a heating and cooling liquid which will transfer heat up to 900°F. is described by engineers of the Du Pont de Nemours Co. Consisting of approximately 40% sodium nitrite, 7% sodium nitrate, and 53% potassium nitrate, the mixture has a low melting point, high heat-transfer rate, and a thermal stability and a lack of corrosive action on steel at temperatures above those obtained with Dowthorm, hot oil, or high steam pressure. Obtainable in salt form, the solid material may be melted with 150 lb. steam pressure at 288°F. and when molten can be pumped like water.

(*Communicated by D.S.R., Ministry of Aircraft Production*).

A Convenient Electrical Micrometer and its Use in Mechancial Measurements, by R. Gunn. (*J. App. Mech., U.S.A., Vol. 7, No. 2, June, 1940, p. 49-52*).

A simple electrical micrometer of great mechanical and electrical stability has been developed. The electrical-current output from the micrometer is accurately porportional to the impressed mechanical displacement. The least count of typical micrometers using portable micrometers as indicators and employing no amplification is 5/1,000,000 in. Zero drift, hysteresis, temperature, and pressure variations have been reduced to less than 1%. Special circuits are described which permit the indication of the sums, differences, ratios, or products of mechanical displacements, and hence are useful in many mechanical measurements. The micrometer is also convenient for low frequency vibration studies.

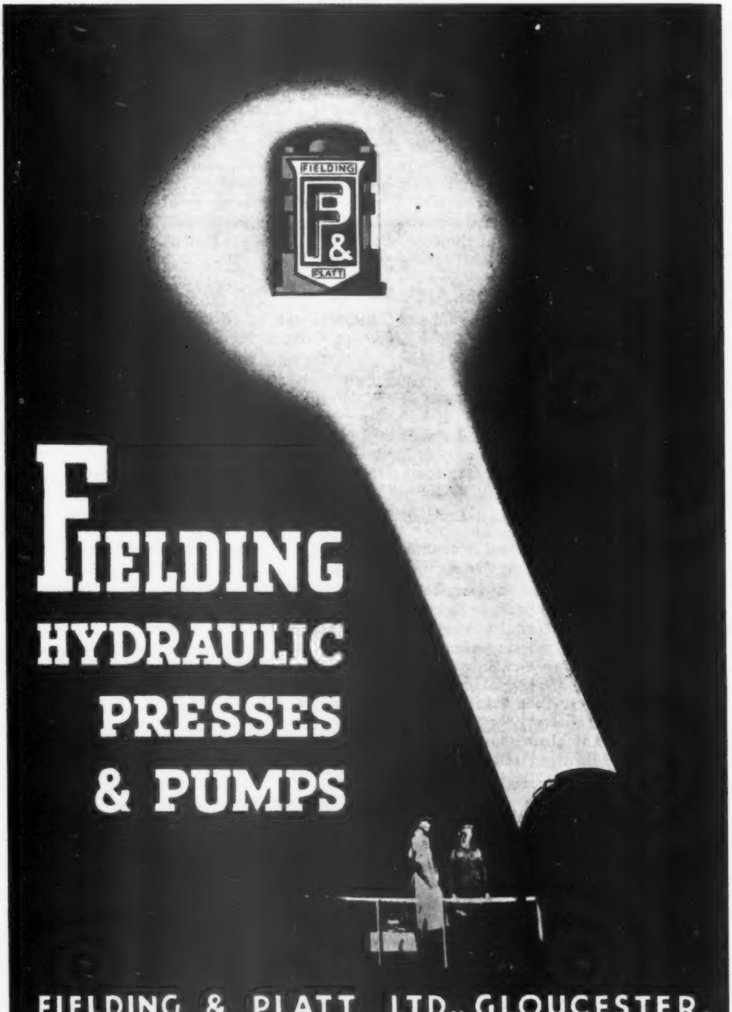
(*Communicated by D.S.R., Ministry of Aircraft Production*).

PLASTIC MATERIAL.

Optical Plastic Materials. (*Mech. Eng., U.S.A., Vol. 62, No. 8, August, 1940, p. 613*).

The new non-mouldable resin can be readily sawed, drilled, turned, and even ground and polished on opticians' laps. It does not exhibit true plastic flow under heat and pressure but may be bent to shape at 160°C. The tensile strength of the material at room temperature is 8,000 to 10,000 psi, and the hardness is 60-62 on a Rockwell C scale with a 68-kg. load and ⅛ in. ball for fifteen seconds. Its stability to sunlight and ultra-violet light is excellent. Non-breakable eyeglasses are now being produced from this material by an optical company on an experimental basis.

(*Communicated by D.S.R., Ministry of Aircraft Production*).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Plastic Aircraft. (*Aircraft Production, August, 1940, Vol. II, No. 8, p. 243. 7 Figs.*).

Wings and fuselage of spruce plywood impregnated with phenol-formaldehyde. Properties of material. An American machine constructed from wood impregnated with a plastic material. The clean contours made possible by this method of production is an important aerodynamic feature. Plywood construction. Special oven where the wood and plastic material are bonded together to produce a rigid component. Assembling the tail surfaces moulded to a precision fit to the fuselage which is secured in an assembly fixture. Component assembly. Service repairs. Under an oxy-acetylene flame the wood could not be burned. The weight was found to be 20% less than it would have been if made of orthodox metal design.

Properties and Performance of Plastic Bearing Materials, by L. M. Tichvinsky (*Transactions of the A.S.M.E., July, 1940, Vol. 62, No. 5, p. 461, 10 Figs.*).

Bearings made of plastic materials can be used successfully not only for the case of perfect fluid lubrication but also for that of semifluid lubrication. Certain additions, such as graphite, will sometimes permit the application of these materials under conditions of dry friction. By virtue of good physical properties these bearings find a wide application. Heavy-duty plastic bearings are used in the steel-mill industry. Lubricated and cooled with water, they carry heavy loads at pressures of several thousand pounds per square inch. As guide bearings their performance ranges from small, high speed spindles, to large ship-propeller shafts. Oil-, water-, and grease-lubricated plastic bearings are used extensively in industrial, marine and farm machinery. There are many differences in the behaviour of plastic and metal bearing materials by virtue of which the performance is also different. The article intends to point out the most important physical properties, as well as some of the characteristic performances of plastic bearing materials.

SMALL TOOLS.

High Speed Steel Cutting Tools and Materials, by L. C. Gorham. (*The Tool Engineer, July, 1940, Vol. IX, No. 3, p. 13*).

High Speed Steel remains a major tool material in spite of the vigorous competition of the Cemented Carbides and of the Stellite types. Two basic groups; those in which Tungsten is the major alloying element, while the Molybdenum group includes those analyses in which Molybdenum is the major alloying element. The newer analyses contain equal amounts of Tungsten and Molybdenum as Molybdenum High Speed Steels. The 18-4-1 analysis is the lowest in price of the Tungsten steels. It is probably the easiest of all High Speed Steels to properly heat treat and rework when necessary Vanadium is added to High Speed Steels to increase the resistance to abrasion. The purpose of adding Cobalt to High Speed Steels is to raise the temperature —red hardness—at which the tool softens under cut. Three rather common types of Tungsten High Speed Steel contain alloyed Cobalt. (1) 18-4-1 with 4% Cobalt added, (2) 18-4-2 with 8% Cobalt added, and (3) a super alloy of 22% Tungsten, 5% Chromium, 1½% Vanadium with 12% Cobalt.

The most widely used of the Molybdenum High Speed Steels is the "Mo-Max" type, containing 8% Molybdenum, 1½% Tungsten, 4% Chromium, and 1% Vanadium. Steels of the Mo-Max type are offered at a distinct saving in cost over either the 18-4-1 or 18-4-2 Tungsten types because of the much lower Tungsten content. The Mo-Max steels may generally be expected to perform as well if not better than either the 18-4-1 or the 18-4-2 Tungsten steels. The newer Molybdenum High Speed Steels contains 4% Molybdenum 4% Chromium, 1½% Vanadium and 5% Tungsten. This analysis minimized

the decarburization problem by increasing the Tungsten content. A Tungsten free material contains 8% Molybdenum, 4% Chromium, 1½% Vanadium and 8% Cobalt, with a Boron addition giving freedom from decarburization and high resistance to abrasion. Heat treatments have been worked out by which Rockwell hardnesses ranging from C60 to C72 may be obtained to suit the individual application. Controlled atmosphere and salt bath furnaces are now almost universally used for hardening High Speed Steels. There are many jobs that definitely cannot be satisfactorily handled with any High Speed Steel. For those the use of either of the Stellite group materials or one of the Carbides are recommended. Cost factors. Savings in machining costs by application of cemented carbides are in the order of 25%. The increases in machine capacity are in the order of 33 to 43%.

Cemented Carbides, by W. G. Robbins. (*The Tool Engineer, July, 1940. Vol. IX, No. 3, p. 16, 23 figs.*).

A discussion of current carbide materials and their uses. Processes and technics in powder metallurgy have progressed in great strides the past 15 years. Three principal groups of carbides. Tantalum carbide, titanium carbide and tungsten carbide. They are all predominately tungsten carbide. Four grades do most work to-day. Domestic machine tools are entirely adequate for efficient carbide tool use. Many types of multiple-point carbide tools are common to-day. Reamers, inserted blade as well as solid, spot-facers, counterborers, drills. Taps of solid carbide have been ground and are in use to-day. They have a very interesting application in ceramics, hard rubbers, aluminiums, bakelite. Thread gauges made of carbide with the threads ground in the solid carbide have a great field of use in gauges in the higher abrasive types of materials. Burnishing tools. Milling cutters. Broaches. Conditions necessary to cut steel with carbides. The horsepower of the machine is important because the tools must run faster and a great number of disastrous results have come from using tools on under-powered machinery. The design of the tools, the rakes and angles, the clearance angles have been simplified and are pretty much a standard proposition to-day. Coolants have some effect. Chip room in the machine is a very important thing. Savings in machining costs by the application of cemented carbides are in the order of 25%. The increases in machine capacity are in the order of 33 to 43%.

Craftsmanship. (*Machine-Tool Review, May-June, 1940, Vol. 28, No. 174, p. 95, 13 figs.*).

Carbide-tipped form tool for turning grooves in shells. Checking the form of the tool by projection on a toolmakers microscope. Dimensions and angles to be checked on the copper banding tool. Template used for checking the form of the shell grooving tool. Dimensions to be checked on a form tool for forming sparking plug adapters. Checking a form tool on the Hilger Projector. Method of checking the form tool for sparking plug adapters.

Die for Making Six Right-angle Bends, by L. K. (*Machinery, August 1, 1940, Vol. 56, No. 1451, p. 543, 2 figs.*).

Die designed to produce a completely formed part at each press stroke. Die shown as it appears in the closed position about to eject the finished piece.

STANDARDISATION.

Involute-Spline Standards—I. (*The Machinist, August 10, 1940, Vol. 84, No. 25, p. 431*).

The standards for side-bearing involute splines are elaborated by the American Standards Association and intended to serve as a basis for the

design of interchangeable spline shafts and fittings. Table 1 and 2. Dimensions of 30 degrees. Involute Spline with 6 Teeth—Fitting (Internal) and Shafts (External). Table 3 and 4. Dimensions of 30 degrees. Involute Spline with 10 Teeth—Fitting (Internal), Shaft)External).

SURFACE TREATMENT.

The Anodizing of Aluminium, by "Anodizer." (*Machinery, August 1. 1940, Vol. 56, No. 1451, p. 545, 6 figs.*).

Surface preparation. Chemical etching and barrel polishing. Sand or shot blasting and scratch brushing. Polishing is carried out in successive stages on calico mops with suitable abrasives. Cleansing is essential after all other processes. Removal of grease, carried out in two stages, namely, solvent degreasing, followed by chemical action. Equilibrium diagram for : (1) aluminium-silicon alloys, (2) Aluminium-iron alloys, (3) Aluminium-zinc alloys, (4) Aluminium-copper alloys, (5) Aluminium-mangesium alloys, (6) Aluminium-magnesium-silicon alloys. Avoid short circuits to the cathodes or the vat and its fittings. The importance of standardizing the anodizing conditions must be stressed. In the latest plants, provision is made for automatically stopping the treatment after the predetermined cycle has been completed. Swilling treatment after anodizing. Colouring is the most delicate part of the processes, and for uniformity of shade demands strict attention to details. The essential requirements of a colouring medium are (1) fastness to light ; (2) ability to resist leaching ; (3) unaffected by perspiration ; (4) ability to resist rubbing especially when combined with (2) and (3) ; (5) maintain the desirable properties of the film unimpaired. Some proved prescriptions are givem. Immediately the work is removed from the dye it must be thoroughly swilled in cold water to remove all surplus colour. Sealing by absorption of oils, etc., must be preceded by thorough drying otherwise patchiness or streaks result. Finishing. Applications of Anodizing on pure aluminium, and alloys with constituents such as silicon, compounds of aluminium-manganese, aluminium-chromium-iron, Magnesium, aluminium-copper-iron, aluminium-copper-nickel. Corrosion resistance. Abrasion resistance. Heat resistance. Reflectivity. Electrical resistance, Absorptive capacity.

Plating of Aluminium Sheet now made practical. (*Inco, Vol. 17, No. 1, Winter Edition, 1940, p. 16*).

Pre-finishing of aluminium sheets by the application of nickel or nickel chromium surfaces before fabrication of the finished product has opened wide opportunities in the metal stamping industry which produces ash trays, reflectors, and a widely diversified number of other articles. Plated aluminium sheets showing the variety of shapes and designs made possible by the American Nickeloid process.

TECHNICAL EDUCATION.

Tool Engineering Education. (*The Tool Engineer, June, 1940, Vol. IX, No. 2, p. 22*).

Industrial Re:uirements in Tool Engineering Education, by C. S. Stilwell. Philosophy of the tool engineer. Competition versus paternalism. Imagination a necessary requisite. Education—vestibule to career of service. Vocational guidance needed. The humanities. Education should develop personality.

University Viewpoint of Tool Engineering Education, by J. W. Barker. Functions of the tool engineer. Post-collegiate training essential. Fallacy of training for first. Fallacy of training for first job. Research—vital to tool engineering.

High School Viewpoint of Tool Engineering Education, by E. L. Bowsher. Education foundation of democracy. Education falls short of ideal. The school concept. Survey of education. High school responsibility two-fold.

Vocational Viewpoint of Tool Engineering Education, by T. P. Orchard. College training not practical enough. Practical instructors necessary. A solution. An effort is suggested on the part of Vocational Schools to establish courses that are really more practical and the employment of real practical instructors.

Discussion of Tool Engineering Education, Don Flater. The author was to discuss the papers as submitted by Messrs. Stilwell, Barker, Bowher and Orchard. Industry desires greater things than just a good engineer. Management defined. Engineer defined. School and factory co-operation. Keeping up-to-date. Well-rounded College background. Aptitude important. Intelligent report writing important. Education a continuing process.

TRANSPORT, TRANSPORT EQUIPMENT.

Cost Reduction in Material Handling, by H. J. Beattie. (*Production Series, No. 122, American Management Association, p. 26, 7 figs.*).

Industrial plants as a whole have so intensely modernized their machinery, without equivalent modernization of their material-handling methods, that further gains in manufacturing efficiency are easier to achieve by revamping their material-handling methods than in any other way. There are three fundamental types of equipment to do the job mechanically, hoists and cranes, conveyors, and trucks. The remarks are confined to trucks. Equipment. Diagram of handling movements. Handling cycles. Storing materials. Diagram of handling movements, comparing hand truck or trailer methods with pallets and fork trucks. Warehousing. Conclusions: (1) Reduces unloading costs. (2) Reduces the time element of handling. (3) Unit loads can be shipped safely in cars without bulkheads and bracing. (4) There is less damage to the material in transportation. (5) There is less damage to cartons and material in storage. (6) Savings may be found in the use of pallet loads as a storage inventory unit, thus reducing the cost of sorting, checking, inspecting and taking inventories. (7) Stocking materials on pallets with the aid of tiering forks has the advantage of being extremely inexpensive. (8) The trucks are a benefit in manufacturing operations as they not only serve as labour-saving apparatus but also as production-aid apparatus.

WELDING, BRAZING.

The Supply of Welding Operators in War-Time, (*The Welder, May-June, 1940, Vol. XII, No. 74, p. 70, 3 figs.*).

Welders in H.M. Forces. Training of welders. Training centres conducted by the Ministry of Labour and National Service. The average of students in this centre is 850; they receive instruction in many different crafts, and employment is found for the majority on the completion of the respective courses.

The Cause of Welding Fissures in Aircraft Steels, by J. Müller. (*L.F.F., Germany, Vol. 17, No. 4, April 20, 1940, p. 97/105*).

The fissures or cracks considered in this article occur between the weld proper and the underlying steel, the surface of the weld appearing perfectly sound. The trouble assumed rather alarming proportions in 1933, when German aircraft constructors adopted welding on a larger scale. Intensive investigations were at once undertaken covering not only the welding technique but also design and materials. It was soon found that the principal reason for the cracks was an excessive sulphur content of the steel. This applies

equally to plain carbon and alloy steels. The steels at present employed in Germany are prepared in electric furnaces and the chemical composition is very accurately controlled. As a result the product is free from accidental impurities and very homogeneous and can be welded without giving rise to any of the troubles mentioned above.

(*Communicated by D.S.R., Ministry of Aircraft Production*).

Low-Temperature Brazing with Silver Alloys, by H. H. Leach. (*Sheet Metal Industries, August, 1940, Vol. 14, No. 160, 877, 3 figs.*).

Table on standard alloys specifications. The components and physical data are : Grade No., Silver, copper, zinc, cadmium, impurities, maximum melting point, flow point, colour. The use of these more expensive alloys shows a large increase. The silver alloys give first better and quicker methods of joining ; and, second, the comparatively low melting-points of these alloys, their free-flowing properties and the strength of joint made with them. Selection of grade and form of brazing alloy. Liquidus diagram of silver-copper-zinc alloys. Any of the standard silver brazing alloys are resistant to most of the common types of corrosion. There is a rapidly growing use of inserts of these alloys because by preplacing them before heating the following advantages are obtained : (1) Control of the amount of alloy used, thus eliminating waste. (2) Better assurance that the alloy will be properly distributed over the joint surfaces and all parts will be wetted. (3) The appearance of the alloy at the edge of the joint is a good indicator that the joint has been heated sufficiently to ensure a good bond. (4) In furnace or salt-bath heating, inserts are necessary, and it is possible to make up assemblies having a large number of joints that can be treated at the same time. (5) When the heating is done with torches the workmen can give his whole attention to applying the flame evenly, and careful control of temperature. (6) Neatness of joints and no spills of the brazing alloy on the surface away from the joint. Fitting, cleaning and assembling. There are several different methods of supplying the heat necessary for brazing. Brazing processes : (1) Gas brazing. (2) Dip brazing. (2a) Metal bath. (2b) Chemical bath. (3) Electric brazing. (3a) Arc. (3b) Induction. (3c) Resistance. (4) Furnace brazing. Application of silver brazing alloys in different industries.

Bi-Metal Foils for Brazing Hard Alloy Tips on Tools. *Z.V.D.I., Germany, May 4, 1940, Vol. 84, No. 18, p. 310/311*).

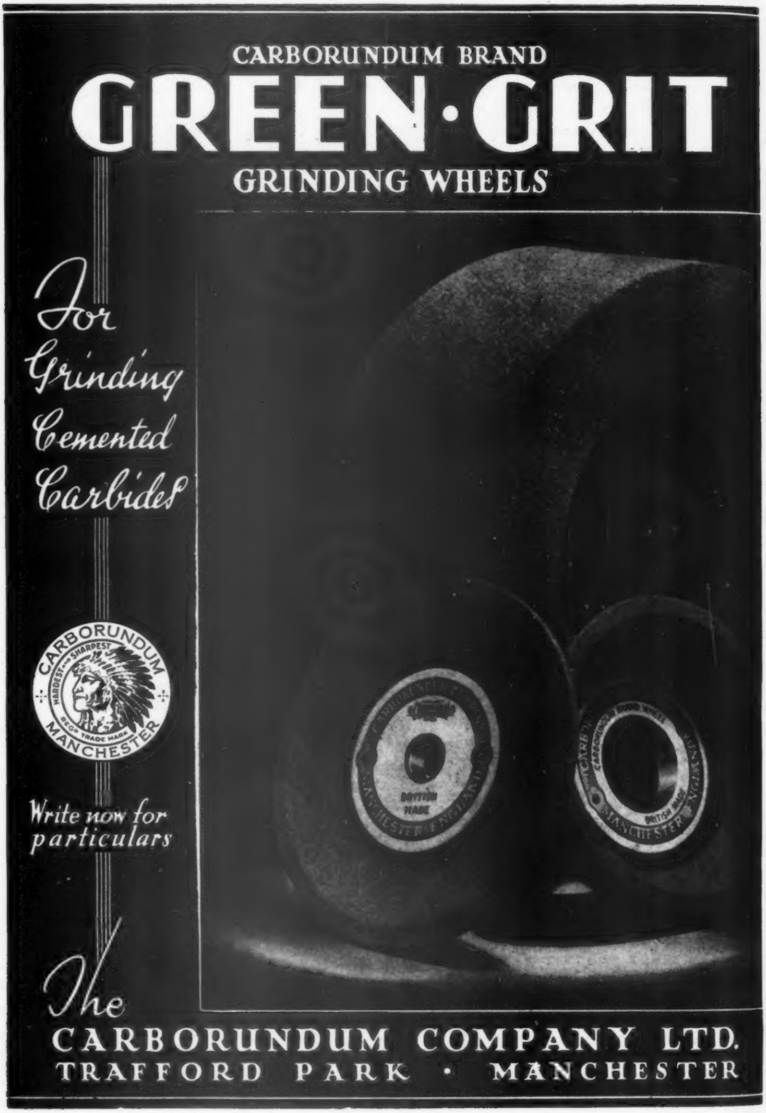
The usual method of brazing hard alloy tips on to the body of the tool may lead to cavities existing between the tip and the tool shaft which may cause the tip becoming unstuck or even fracturing. This difficulty is overcome by making use of special copper-steel foil, consisting of small grooved steel plates covered with silver solder and embedded in a copper solder. This foil is placed in the cut out portion of the tool, the tip placed in position and the whole heated in a muffle furnace to the requisite temperature. Details of the subsequent treatment are given and it is stated that perfect adhesion can be ensured for tips of not more than 3-4 mm. thickness.

(*Communicated by D.S.R., Ministry of Aircraft Production*).

WELFARE, SAFETY, ACCIDENTS.

Safety, by G. P. Barnett. (*Industrial Welfare and Personnel Management, August, 1940, Vol. XXII, No. 261, p. 260*).

In 1938 some 944 workers were killed in industrial establishments of this country and 179,159 injured so as to disable them from carrying on their work for more than three days. Of these accidents 73 or 7.7% of the fatal and 30,652 or 17.1% of the non-fatal accidents concerned young persons, *i.e.*,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those under 18. Young worker Safety Committee. Guarding machinery. Other protective devices. Falls of materials. Personal falls. Protective equipment. Danger from air attack. Organising a scheme. Fire fighting. First aid.

Electrically Operated Safety Devices for Press Tools, by J. R. Fawcett. (*Machinery, August 22, 1940, Vol. 56, No. 1454, p. 636, 7 figs.*).

Mandrel type piercing tool fitted with electric safety contact. Clapper type Electro-magnet which serves as a safety catch for the operating press pedal. Circuit diagram which ensures that two consecutive operations are performed in the correct sequence. Wiring diagram for an automatic press stopping arrangement. Press tool arranged to stop the machine in the event of punch breakage or exhaustion of strip stock supply.

INDEX TO ADVERTISEMENTS

Research Department: Production Engineering Abstracts

(*Edited by the Director of Research*)

ANNEALING, CASE-HARDENING, TEMPERING.

Correct Heat-treatment Technique by Means of Salt Baths. (*Sheet Metal Industries, September, 1940, Vol. 14, No. 161, p. 943, 6 figs.*).

A high-production gas-fired salt bath unit supplied to one of the largest light alloy rolling mills in this country for normalizing duralumin sheets. The bath accommodates sheets up to 10 ft. long by 4 ft. wide, in loads up to 15 cwt. per charge. A salt-bath furnace 15 ft. long. A small salt bath such as is used in laboratories of light alloy factories. Two gas-fired salt baths for fabricated parts. The size of bath is 15 ft. 6 in. long by 2 ft. wide by 2 ft. 3 in. deep.

The How and Why of Time Quenching, by J. L. Burns and V. Brown. (*Machinist, September 14, 1940, Vol. 84, No. 30, p. 523, 8 figs.*).

When water quenching is too severe, and oil does not give sufficient hardness, a double or "interrupted" quench may produce the desired results. Curves taken across the section of a 0.40 C steel bar, 1½ in. in diameter, showing the variation in hardness for different time intervals. Quenching conditions. Cross section. Time. Macrographs of etched cross-sections of a 0.60 C steel bar show the varying depths of hardening effect for different quenching conditions. Hardness penetration. Grain structure of a typical piece. Heat flowing from the centre of the bar may make the outside surface softer than the sub-surface area. Tempering will level this hardness gradient.

ACCOUNTING AND ADMINISTRATION.

How Job Evaluation Contributes to Cost Reduction, by A. F. Kindall. (*Production Series No. 124, American Management Association, p. 16*).

Simple versus complex rating plan. Formulation of plan through consultative supervision. Who should do the rating? Advantages of job evaluation. Criticisms of job evaluation. Can managerial and supervisory positions be rated? Job evaluation is essential if business is to pay a fair day's pay for a fair day's work. Efficiency cannot be attained until wage and salary rates are fair and equitable. The many by-product advantages of the job evaluation procedure more than make up for the cost of applying the procedure. And, lastly, every person in the organization becomes familiar with the duties and functions, and responsibilities of his job if job evaluation is properly executed.

EMPLOYEES, WORKMEN, APPRENTICES.

Fitting the Worker to the Job, by W. H. Edwards. (*Industrial Welfare and Personnel Management, August, 1940, Vol. XXII, No. 261, p. 246*).

Education. Selective examination. Training. The first year in the correct way of manipulating the machine tool, vice work, heat treatment, practical drawing by measurement of the tools. In the second year the boys are again employed for a suitable period on every machine and operation on more ad-

vanced work requiring skill in manipulation and setting up. Cleaning. Making tools. Physical training and A.R.P. Technical college. Record of progress. War-time training.

GEARS.

Gear Tooth Deflection and Profile Modification, by H. Walker. (*The Engineer, August 16, 1940, Vol. CLXX, No. 4414, p. 102, 4 figs.*).

A method to determine the profile modification for a gear of given proportions. Some notes on the effect of manufacturing errors on dynamic tooth loads. Test results on gears of British standard tooth form 20 degrees pressure angle, from which it is possible to ascertain the tooth deflection at any point on the profile of a gear having any number of teeth, with the above tooth form. Derivation of modification factor for the general case. Effect of manufacturing errors on dynamic tooth loads. Heavy duty gears are remarkably sensitive to pitch or form errors in the vicinity of the tip of the wheel tooth and the base of the pinion tooth, and tooth abrasion frequently occurs at these positions. Flexibility of the teeth is an advantage in reducing the dynamic tooth loads. A larger radius at the root of the tooth avoids the stress concentration which occurs when the radius is small.

HEAT, HEAT ECONOMY.

Utilization of Heat Waste, by S. G. Saunders. (*Journal of the Institution of Heating and Ventilating Engineers, August, 1940, Vol. 8, No. 90, p. 209, 4 figs.*).

Every effort should be made to obtain the utmost economy in consumption of both home produced and imported fuels used in private plants, as a contribution to the national war effort. The metallurgical and carbonising industries afford examples of efficient and organised planning as regards waste-heat recovery. An attempt is made to present in comprehensive form the essential data required when potential schemes are under consideration. Combined power and heating plants. Methods of electrical generation available. Steam power plants : (*a*) Reciprocating steam engines, (*b*) steam turbines. Types of engines and turbines available. Steam consumptions. Small turbines. Internal combustion engines. Recovery from cooling water system. Recovery from exhaust gases. Quantity of heat available per B.H.P. Graphic co-relation between excess air, CO_2, and oxygen for oil engine exhaust gases. Use of exhaust gases for steam raising. Waste heat boilers. The most efficient results are obtained by maintaining turbulent flow over the heating surfaces thereby producing a good "scrubbing" action. Instances where excess waste heat, available during the summer months, could be usefully employed in conjunction with water-vapour systems of cooling for air-conditioning purposes. Heat recovery from re-evaporated steam. Power and heat recovery from sewage gas. Description of system and nature of gas. Quantities of gas generated and waste heat available. Utilization of the waste heat in the form of gas or hot water. The whole question of recovering waste heat in every possible field should be pursued with the utmost energy as part of our national salvage scheme. Efficient waste-heat recovery, however, will nearly always be found a sound financial investment from the point of view of peace-time operation.

JIGS AND FIXTURES.

Automatic Intermittent Tap-relieving Attachment. (*Machinery, September 19, 1940, Vol. 56, No. 1458, p. 757, 1 fig.*).

Aircraft components made from high-tensile materials and of light section provide typical examples for which intermittent relieving of the tap can show good results. The attachment is shown in the illustration.

KINEMATICS.

The Differential Screw, by P. G. (*Mechanical World, September 20, 1940, Vol. CVIII 2803, p. 216, 14 figs.*).

In general the differential screw principle has been applied for the following purposes : (*a*) Fine adjustment for measuring purposes, (*b*) to obtain a high ratio between input and output force, (*c*) smaller friction losses and self-locking power. Principles of differential screw mechanisms. Fixing the conical shaft of a milling cutter. Fine adjustment of the inserted shank of a boring bar. Turning tool with fine adjustment and marking device. The same principle is useful as a stop for fine adjustment. Fine adjustable screw vice with high clamping power. Screw press with double actuation. Safety dog for lathes utilizing the differential screw principle. Mechanism for the relative adjustment of shafts. Micrometer adjustment for a boring bar tool.

Hydraulic Circuits Utilizing Cam and Electrically-operated Valves, by J. C. Cotner. (I *Machinist, August 24, 1940, Vol. 84, No. 27, p. 288e, 6 figs.*, and II *September 7, 1940, Vol. 84, No. 29, p. 306e, 4 figs.*).

I—Methods of obtaining and timing various machine motions by means of hydraulic circuits are shown. Automatic control of fixtures on milling machine. Multiple valves controlled by single cam. Controlling automatic drilling and forming machine. Controlling hydraulically operated welder. Controlling automatic drilling and forming machine. Arrangement for combined staking machine and press. II—Arrangement for 4-Spindle chucking machine. System for moulding machine. Arrangement for automatic press. System for mirror polishing machine.

Electric Clocks, by F. G. Atkinson. (*Journal of the Institution of Electrical Engineers, August, 1940, Vol. 87, No. 524, p. 218, 3 figs.*).

Any modern electric clock belongs, in first principles at least, to one or other of the following groups : (1) The impulse system, (*a*) the master clock or regulator, (*b*) the secondary clock, (*c*) the battery or power supply ; (2) self-contained electric clocks ; (3) synchronous alternating-current motor clocks, (4) synchronized clocks ; (5) electrically-wound clocks.

MACHINE ELEMENTS.

Roller Bearings and their Application to Machine Tools. (*Machinery Lloyd, September 7, 1940, Vol. XII, No. 18, p. 21, 12 figs.*).

The use of tungsten carbide and other tipped tools on machine tools has introduced numerous problems in their design and operation. The most serious difficulty of all is the question of the main bearings. A tapered roller bearing with flanged cup or outer race. There are three sources of error : (*a*) Eccentricity between inside and outside of the cup (outer race), (*b*) error in axial alignment of cylindrical exterior and conical interior of cup, (*c*) eccentricity between inside and outside of cone (inner race). Design for four-bearing mounting of work spindle. Three-bearing mounting of work spindle. Two bearing mounting of work spindle. Three-bearing mounting for intermediate spindles. Design for geared lathe headstock. Standard flangeless bearings are used. Live tailstock for small or medium centre lathes. Tailstock centre for heavy lathes. High-speed internal grinding wheel spindle. Three-bearing mounting for vertical milling machine spindles. Vertical grinder spindle with automatic oil circulation.

Bearing Mounting Practice of Tapered Roller Bearings IV, by E. H. Doughty. (*Power Transmission, September 15, 1940, Vol. 9, No. 104, p. 365, 12 figs.*).

Methods of bearing adjustment : I—Adjustment through bearing cone, the illustrations show (*a*) single nut, (*b*) double nuts, (*c*) end plate, (*d*) cone

spacer, (*e*) two-row D.O. type bearings with cone spacer, (*f*) two-row N.A. (double cup) bearings. II—Adjustment through bearing cup, the fit should not be so tight as to interfere with the adjustment; (*a*) end cover (*b*) end cover with extension, (*c*) screwed end sleeves and covers, (*d*) cup spacer.

Speedy Methods of Sheet Metal Assembly, by A. J. Gibbs-Smith. (*Sheet Metal Industries, September, 1940, Vol. 14, No. 161, p. 981, 7 figs.*)

The spring tension clip, known as the " speed nut," is being increasingly used in a number of other trades. The device in question consists essentially of a flat piece of metal, arched lengthways, a hole being pierced and slit in such a manner as to form prongs which engage the teeth of the screw on which the clip is being used. Illustrations show " speed nuts " applied respectively to a machine screw, a sheet metal screw, and a rivet. There are now more than 250 different designs manufactured on a production scale, and it is stated that the production of the various types exceeds 125 million per annum.

Slip Couplings, by R. Waring-Brown. (*Power Transmission, September 15, 1940, Vol. 9, No. 104, p. 342, 9 figs.*).

A short treatise on safety coupling devices utilized in prime mover drives, machinery assemblies, and power transmission lines. The figures show. Simple slip coupling. Single disc slip coupling. Pulley slip coupling. Plate type slip coupling. Twin-disc slip coupling. Multi-disc slip coupling. Band type slip coupling. Cam type slip coupling. Slip coupling for electric windlass.

MACHINING, MACHINE TOOLS.

Routine Production Operations on Keller Machines. (*Machinery, September 19, 1940, Vol. 56, No. 1458, p. 745, 10 figs.*).

Automatic control of intricate milling operations in armament and aero engine manufacture. Fixture for holding three connecting rods with the necessary templates and former for simultaneous milling. Operation sketch showing the milling of the channels and external profile of an aero engine connecting rod. Set-up for milling the channels in three connecting rods simultaneously. Set-up for profiling the combustion chambers of an aero engine cylinder head casting. Special turret type indexing fixture for use in the milling of aero engine crankshafts. Stages in the manufacture of sprockets for tanks on a kellermatic.

The Orcutt Hydraulic Gear-tooth Grinder. (*Engineering, September 13, 1940, Vol. 150, No. 3896, p. 204, 8 figs.*).

The mechanism for reciprocating the main horizontal slide is generally similar to that employed on other hydraulically-operated grinders. Detailed description of the machine, particularly of the hydraulic drive of the slide, the indexing mechanism and the trimming devices for the wheel, the flanks and crest being trimmed separately. One of the most important and interesting features of the machine is the illustrated indexing mechanism. A half revolution of the index shaft will advance the index plate one tooth. It is impossible to operate the indexing mechanism while the grinding stroke is in operation, or vice versa. The main control lever on the panel simply controls the oil supply from the pump to a timing valve. The latter valve has four positions, two controlling the ram cylinder, and two the indexing cylinder.

MACHINING WITHOUT CHIPS.

General Principles of Die Design, by B. G. Ross. (*The Australasian Engineer, July 8, 1940, Vol. 40, No. 290, p. 10, 8 figs.*).

The proper classification of various types of dies. First, dies which simply cut or punch flat blanks of the required outline from the stock. Second, dies

which change the form of the stock from its original flat condition by drawing forming, or bending it. Stock used for press work. The different grades of steel are known as hard, half hard, medium soft, dead soft, and special dead soft. Brass is also available in the following grades : dead soft, soft, quarter hard, half hard, hard, and high hard. The shearing action of metals illustrated. Punch clearance in blanking and piercing. Where to apply punch clearance. Die clearance. The shut height of the press indicates the die space when the slide or ram is at the bottom of its stroke and the slide connection has been adjusted upwards as far as possible. For punching, shearing, and blanking ordinary metals, not more than ¼ in. thick, the speeds usually vary between 50 strokes per minute and 200 strokes per minute, 100 strokes being a fair average. For metals more than ¼ in. thick geared presses with speeds ranging from 25 to 75 strokes per minute are generally used. The cutting pressure required depends upon the shearing strength of the metal and the area of the surface being severed. The tensile strength may be roughly substituted for the shearing strength. It may be roughly assumed as follows—

	Lb. per sq. in
Mild steel	60,000
Wrought iron	50,000
Bronze	40,000
Copper	30,000
Aluminium	20,000
Zinc	10,000
Tin and lead	5,000

Economics in laying out blanking dies. Relation between the form of stamping and the direction of the grain of the stock. Types of piercing punches and methods of holding. Preventing punchings from sticking in the die. The use of cerromatrix for fixing punches and dies. Cerromatrix is an alloy of bismuth, lead, tin, and antimony, and it has the unique advantage of expanding upon cooling (about .002 in. per inch). Industrial or hard chromium plating.

Plane Parts from Strip Stock, by Larry Boeing. (*The Machinist, August 17 1940, Vol. 84, No. 26, p. 462*).

If roller type dies are used properly, complex structural shapes can be rolled to shape quickly. Easy fastening and speedy production result.

Suspension of Stripper Plates, by J. S. Karash. (*Machinist, September 14 1940, Vol. 84, No. 30, p. 534, 5 figs.*).

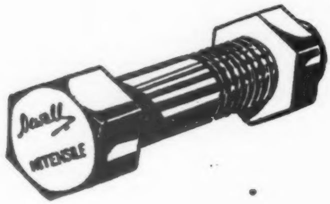
Methods of suspending stripper plates and points in favour of interchangeable punches and dies.

Which Stripper Mechanism ? by J. I. Karash. (*Machinist, August 17, 1940, Vol. 84, No. 26, p. 466, 6 figs.*).

Strippers are designed to save time before and after regrinding operations, Examples : Stationary stripper plates. Follow die strippers. Overhung stripper plates. Bridge-type strippers. Removable elastic strippers. Rubber stripper cost low. Removable spring strippers. Removable sleeve strippers,

More about Stripping, by J. I. Karash. (*Machinist, August 31, 1940, Vol, 84, No. 28, p. 500, 5 figs.*).

The illustrations show : Knock-out pins have definite advantages from the standpoint of die maintenance cost, and are particularly useful for single punchings made in inclinable presses. Punch holder drilled for a knock-out pin, making a flexible arrangement which can be used for unit operation in an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inclinable press, or with a spring for punching a series of blanks. Set-screws are used to hold the stripper plate in a retracted position so that punch and die can be engaged for setting up in the punch press without guide posts. Dismantling and readjustment of punch and stripper plate is accomplished by designing them so that both may be ground at the same time. Design combining the advantages of simultaneous grinding of punch and stripper with the possibility of dismantling the stripper without removing the punch.

MANUFACTURING METHODS.

High Precision Manufacture. (*Automobile Engineer, September, 1940, Vol XXX, No. 401, p. 263 ,11 figs.*).

A survey of the production methods at Bryce Fuel Injection, Ltd. In the production of fuel-injection equipment for oil engines, precision of a very much higher standard than usual is necessary. Working tolerances on fuel pump barrel. Working tolerances on fuel pump plunger. Set-up on horizontal drilling machine for leak-off hole in fuel pump barrel. Jig for milling and grinding plunger dogs, for drilling feed-hole in nozzle holder and for drilling leak-off hole in pump barrel. Working tolerances on nozzle and needle. Set-up for drilling spray orifices on Alfred Herbert air drill. Finally, the complete equipment is subjected to running tests. The pumps are tested and calibrated on a battery of test machines that simulate exactly the working conditions. The percentage of rejects is very low despite the severity of the tests which the equipment undergoes.

Airplane Production in the U.S.A. (*Machinery, September 5, 1940, Vol. 56, No. 1456, p. 686, 45 figs.*).

A series of articles describe the methods of several prominent factories : (1) Typical methods employed at the Lockheed plant. (2) The practice of the Boeing Aircraft Co. (3) Examples of operations at the Vultee plant. (4) The practice of the Wright Aeronautical Corporation. (5) Representative operations at plant of Allison Engineering Co. (6) Methods employed in the Pratt & Whitney plant.

Rolling Airscrew Blanks. (*Aircraft Production, September, 1940, Vol. II, No. 9, p. 275, 4 figs.*).

Recent developments to improve the fatigue properties of aluminium and magnesium alloys. Airscrew production process. A sectional view of the rolls. The circumference of the roll is cylindrical and that the bottom of the grove is tapered in depth. Arrangement of the rings. Heating the billets.

New Type of German Canned Food Container. (*Ind. and Eng. Chem., Germany, Vol. 18, No. 13, July 10, 1940, p. 589*).

New type of can container for packing food products, dispensing altogether with the use of tin plate, has been developed in Germany, according to a report from the American Consulate General, Frankfort-on-Main. Instead of tin for coating the iron, the base sheet for making the new type of can is coated with a phosphate film applied by the well known Bonder phosphate rustproofing process, controlled by the Metallgesellschaft A.-G., of Frankfort-on-Main. Instead of being soldered the can is welded, enabling a further saving of 2% in can material. Special automatic machinery has been developed for achieving the welding in an efficient manner. By means of the Bonder process a thin, tight, and uniform phosphate film is placed upon the iron sheet in two or three minutes by immersion in a special phosphate bath. The entire production process requires thirty minutes.

(*Communicated by D.S.R., Ministry of Aircraft Production*).

Machining Aluminium, by A. F. Coneen. (*The Tool Engineer, August, 1940, Vol. IX, No. 4, p. 18, 3 figs.*).

The tools should have appreciably more top and side rake than those for cutting steel. Most of the tools are made of high speed steel. Tools tipped with tungsten carbide give excellent results and are almost indispenable in machining aluminium alloys of a high silicon content. Advantages : (1) Their cutting edges remain sharp for longer periods without grinding. (2) They produce smoother machined surfaces. (3) They can be used at a higher rate of production. (4) They maintain closer dimensions on the work. Paraffin or mineral oil to which may be added about 5% to 10% of a fatty oil will produce satisfactory results. The standard twist drill and four variations. Spiral pointed taps were designed for tapping through holes, or blind holes when they are drilled deeply enough to allow clearance for chips at the bottom of the hole. Forming tools. Lathe tools. Milling cutters. Circular saws.

The Machining of Zinc Alloys. (*Machinery, September 12, 1940, Vol. 56, No. 1457, p. 728, 12 figs.*).

The turning of zinc alloys presents certain difficulties since zinc, like aluminium, easily " spreads " while the cuttings show no tendency to break. The following processes must be considered—turning, drilling, reaming, core-drilling, thread-cutting, milling, sawing, planing, filing, and grinding. Turning tool for zinc alloys. Curves showing relationship between cutting speed and cutting temperature. Curves showing relationship between cutting forc and cutting speed. Turning tool with chip-breaker groove. Twist drill ground at the point to ensure the breaking up of chips. Form of tap suitable for zinc alloys. Forms of milling cutters recommended. Zinc alloys should be milled by the down-cut method. Inserted-tooth cutter head suitable for milling zinc alloys. Form of tooth recommended for sawing zinc alloys. Widely spaced teeth reduce the risk of clogging. Shape and disposition of file teeth suitable for use on zinc alloys. Ample chip space is desirable.

Flame Machining, by J. G. Magrath. (*Machinist, August 31, 1940, Vol. 84, No. 28, p. 503, 26 figs.*).

Gouging by means of the oxyacetylene torch has many uses and is a time saver as compared to other methods. A number of applications for this process have proved satisfactory. Removal of tack welds, defective welds, roots of welds, defects in steel castings, forgings, plate, etc. Removal of welds from temporary brackets, holders, lifting plates, flanges from pipe, heads from boilers. Removal of scale congested tubes from boiler heads and manual grooving for plate-edge preparation. Advantages : The process proceeds at a forward speed of one to three linear feet per minute. With acquired correct technique a tolerance of $\frac{1}{32}$ in. on width and depth can be maintained. Din and vibration are absent. The light-weight apparatus provides for quick set-ups in shop, yard, or field. There are no tools to be repeatedly reconditioned. Operated on low oxygen pressures, providing low velocity oxygen flow, there is good control of direction in guiding path of gouge or groove. Ability to operate in ordinary inaccessible spaces.

MATERIALS, MATERIAL TESTING.

Aluminium Alloy Practice in Europe, by E. V. Pannell. (*Iron Age, U.S.A., June 13, 1940, Vol. 145, p. 25*).

The article comprises a survey of aluminium-base casting alloys currently produced and used in Great Britain and in Europe. (Data on a few aluminium alloys of American origin are included for comparison). Following a summary

of the classes of addition elements used for control and modification of the properties of aluminium casting alloys, the author gives an alphabetical list of " named " alloys, showing average composition, the sources of supply, and the uses of the various types.

Production of Magnesium Alloy Aircraft Parts, by L. B. Grant. (*J.S.A.E., U.S.A., Vol. 47, No. 2, August, 1940, pp. 325-31*).

The author reviews the progress made and discusses the problems encountered by aircraft manufacturers in the production of aeroplane parts made from magnesium alloys. Although the procedures instrumental to the use of magnesium alloys are not unduly difficult or complicated, they should be well understood and rigidly followed so that the best results can be obtained from the use of magnesium. The composition, mechanical properties, and correlations with Government specifications are given in seven tables. Specific recommendations are made on design, pattern construction, chemical surface treatments, machining, assembly protection, and painting. Information also is given on welding, riveting, and forming of sheet and extruded shapes.

(*Communicated by D.S.R., Ministry of Aircraft Production*).

Zinc Alloy Castings, by E. E. Halls. (*Machinist, September 14, 1940, Vol. 84, No. 30, p. 315*).

The intensive work carried out in America, which culminated in the commercialization of satisfactory zinc casting alloys, can most efficaciously be s mmarized by quoting the results. (1) Correct alloying elements and avoiding certain impurities, notably tin, lead, and cadmium. (2) Determination of alloying elements. (3) Statement of percentages of dangerous impurities. (4) Practical test for establishing whether or not a casting will fail in practice. (5) Introduction of the most favourable technique for zinc alloys. (6) Exploration of protective and decorative finishing processes. Mazak alloys. Mechanical values. Functions of alloying elements. Alloy comparisons. Advantages of zinc castings. Low casting temperature of 400° to 450°C. as compared with 650°C. for aluminium alloys. Die life is longer, and closer dimensions and better surfaces are maintained. Small shrinkages in cooling and smaller dimensional tolerances.

A New High-temperature Alloy. (*Mech. Eng., U.S.A., Vol. 62, No. 8, August, 1940, pp. 613-4*).

The Westinghouse research laboratories have produced a new alloy, containing only 7% iron, which is tronger than any known steel. It retains its strength at temperatures higher than 2,000°F. The alloy, which is the result of almost seven years of research work, is actually stronger at 1,100°F. than ordinary low-carbon steel is at room temperature. Stranger still, it has a low damping coefficient, or in other words, it retains its elasticity at such elevated temperatures. Almost half of K-42 B, as it is known, is nickel, and about a quarter is cobalt. Other components include chromium, titanium, and iron. Production of the metal on a commercial scale is known to be practical, but its first cost will be high, and its immediate uses are expected to be those of a special-purpose alloy for dies, valves, steam fittings and, possibly, turbine blades and other applications requiring temperature-resistant metals. It is reported that the new alloy " creeps " a great deal less than other metals in its class.

Cast Iron Cylinder Bores (Microstructure, Composition, Hardness, and Wear), by E. K. Smith. (*J.S.A.E., U.S.A., Vol. 47, No. 2, August, 1940, p. 28*).

In a summary of the effect of the various elements of cast iron on its microstructure when other variables are considered constant, it is brought out that

and oil. Therefore, rubber belting covers to-day a great field of application. Oil resistance. Bonding metal. In printing Neoprene rubber is more resistant to the action of the inks than is natural rubber. From the engraver's viewpoint Neoprene is equal to rubber, for dies cut clean and hold their edges, and it is not subject to crumbling or nicking under working conditions. Fire resistance. Physical properties. Specific gravity of Neoprene is 1.25. Tensile strength and resistance to abrasion are normally equal to rubber, and superior under conditions where heat, oil, or chemicals are in evidence. Flexible ebonite.

MEASURING METHODS AND APPARATUS.

Modern Measuring Instruments and the Principles of their Design, by Geo. Schlesinger. (*Machinery, September 26, 1940, Vol. 56, No. 1459, p. 782, 17 figs.*).

In this article are considered the refinements of fits and limits, the possibilities of accurate measurement, the character and range of the necessary instruments, direct reading and estimation of fractions of divisions, and the formulae for calculating the degree of magnification. The measuring system may be based on : (1) Mechanical means. (2) Optical means. (3) Micro comparator gauges. (4) Methods of " active " calibration. Examples : Differential screw micrometer. Single multiplying lever. Tubular type indicator. Passameter external indicating gauge. Passimeter internal indicating gauge. The minimeter amplifying mechanism. Rigid tubular support for dial gauge. Dial indicator. The Cooke, Troughton & Simms' optical comparator. Precision levels. Ultra-optimeter. Taylor, Taylor & Hobson 200-profile projector.

The Microscope as a Shop Tool, by J. Dauber. (*Machinist, September 14, 1940, Vol. 84, No. 30, p. 530, 6 figs.*).

The scale micrometer microscope. Moving microscope-fixed stage instruments. Cathetometers for accurate measurement of vertical distances. Telescopes. For distant objects. The toolmaker's microscope. Different types of eye-piece fields (reticles). The filar eye-piece in a standard microscope for measuring the object with a micrometer screw instead of a scale on ther eticle.

Photo-elastic Analysis of Stresses in a Steam-turbine Blade Root, by J. J. Rayan and J. T. Rettaliata. (*Transactions of the A.S.M.E., August, 1940, Vol. 62, No. 6, p. 503, 21 figs.*).

The analysis of the stresses in steam-turbine blade roots by photo-elastic methods has particular reference to the determination of the loadings on the multiple steps. In this paper, from a comparison of test and calculated values, the stress-concentration factors are obtained for the neck and step sections. Description of problem. Description of apparatus. Test procedure. Original test data. Results of tests. Forces and tensile stresses in neck sections. Tensile stresses in necks of blade. Tensile stresses in neck of spindle. Comparison of blade and spindle stresses. Comparative designs of blade roots. Approximate values of fillet ratios.

PLASTIC MATERIAL.

Permanence of the Physical Properties of Plastics, by J. Delmonte. (*Transactions of the A.S.M.E., August, 1940, Vol. 62, No. 6, p. 513, 24 figs.*).

Plastic materials are subject to certain changes in physical properties during their various applications. Particularly significant are the creep and cold-flow phenomena. A general equation is developed expressing plastic deformation rate as a function of a coefficient of viscous resistance and of a coefficient of internal resistance. Data for laminated phenolics, polyvinyl chloride acetate, methyl methacrylate, polystyrene, and cellulose acetate are compared. Experimental evidence is presented to show that after a sufficient

length of time plastic deformation assumes a constant rate, continuing indefinitely. The dual nature of the molecular structure of plastics is emphasized, in which true elastic deformation may occur, as well as a time-dependent plastic deformation, even at very low stresses. Further data are presented on the shrinkage of various plastics after exposure to elevated temperatures, and the swelling of these materials after exposure to high humidity or water immersion. Loss in impact strength upon exposure to high temperatures is also disclosed for laminated phenolics.

Plastic Bodywork, by F. C. Sheffield. (*Automobile Engineer, August, 1940, Vol. XXX, No. 400, p. 229, 12 figs.*).

A summary of the new technique developed in Germany. The motor industry has become accustomed to the use of moulded synthetic resins for a variety of minor components. The huge Auto Union concern was actually engaged in full-scale experimental work to produce bodies by a combination of steel and resin. Pre-formed panels and structural members are constructed from laminated sheets or strips of paper or fabric impregnated with synthetic resin and consolidated under heat and pressure to the desired shape and section. A pressure of 400 kg. per square centimetre (approximately 5,700 lb. per square inch) is suggested, and it is claimed that pressings of this nature have a strength comparable only to that of sheet steel. Mould for continuous double walled body. Reinforcement of double-walled structure. Single-walled body with metal floor. Built-up body with separate floor. Division of body components. Standardized foundation for roofs or hoods. Roof treatment. Roof or hood joints. Single-unit body shell. Wall structures. Metal joint strips for pre-formed structural units. Door of laminated plastics. Modified door of synthetic material with fibrous filler. Laminated dashboard as structural member. It can scarcely be supposed that plastics will either rapidly or completely displace metal in body construction. Many factors need to be taken into consideration attempting to assess the relative value.

Optical Plastic Materials. (*Mech. Eng., U.S.A., Vol. 62, No. 8, August, 1940, p. 613*).

The new non-moldable resin can be readily sawed, drilled, turned, and even ground and polished on opticians' laps. It does not exhibit true plastic flow under heat and pressure but may be bent to shape at 160°C. The tensile strength of the material at room temperature is 8,000 to 10,000 psi, and the hardness is 60-62 on a Rockwell C scale with a 68 kg. load and $\frac{1}{8}$ in. ball for fifteen seconds. Its stability to sunlight and ultra-violet light is excellent. Non-breakable eye-glasses are now being produced from this material by an optical company on an experimental basis.

Practical Moulds for Plastics, by G. P. Lehmann. (*Machinist, August 31, 1940, Vol. 84, No. 28, p. 489, 6 figs.*).

There are seven principal types of moulds in use in the plastics industry. These are : (1) The flash mould. (2) The landed plunger mould . (3) The loading plate mould. (4) The straight plunger mould. (5) The injection mould. (6) The transfer mould. (7) The sub-cavity mould. Illustrations : (1) Cavity in a flash-type mould has sides which terminate sharply with the top surface of the lower mould member. Excess material is pinched off to a thin fin when the plunger has entered the mould cavity. (2) Accuracy of alignment of mould members makes the landed plunger mould especially suitable for parts with very thin sections. (3) In the loading shoe type mould the loading plate rests on bottom steam retainer shoe and the cavity. Push rods reset the knock-out bar. (4) In a straight plunger mould the ram exerts full pressure on the

moulding compound, resulting in greater density in the product. (5) Because of the high pressures used, it is important that members of injection moulding dies be perfectly finished and aligned. (6) Cleaning costs are low for plastic parts produced in transfer-type moulds which inject heat-softened material into a heated mould.

PSYCHOLOGICAL INVESTIGATION.

The Selection of Man with Creative Ability, by F. Alexander Magoun. (*Mechanical Engineering, September, 1940, Vol. 62, No. 9, p. 670*).

Two major divisions concerning neither of which do we know much. (1) The problem of defining the characteristics of creative ability, and (2) the problem of identifying them. Men with creative ability always have (1) original ideas, (2) the capacity to make them workable, and (3) the persistence to keep at it, until something is really accomplished. The characteristics of an interview which will show whether a man has originality, common sense, and persistence. The excellence of any interview depends upon three things : (1) The ability of the interviewer, (2) the attitude of the interviewee, and (3) the validity of the diagnostic situations. Good method in selecting men with creative ability takes time, both in the development of the art and in its execution. But good selection is worth all the time that it takes.

SMALL TOOLS.

The Maintenance of Milling Cutters, by F. H. (*Mechanical World, August 30, 1940, Vol. CVIII, 2800, p. 154, 12 figs.*).

An analysis of sharpening methods. Ordinary tooth-rest and type for close situations. A cup-wheel is used more often than a disc because of the stronger clearance which it gives. Accurate location by the formed surface ensures uniform teeth. Master-forms for controlling the twisting of a spiral-fluted cutter. Types of tooth-rests. Double-slope rest for staggered-tooth spiral mills. Micrometer and wedge adjustment of tooth-rest. Holder to present shank mills in universal head. Mounting cutter on roller-bearing head.

STANDARDIZATION.

Involute-spline Standards, by the American Standards Association. (*Machinist,* II *August 24, 1940, Vol. 84, No. 27, p. 473, 10 figs.,* III *September 7, 1940, Vol. 84, No. 29, p. 511, 7 figs.*).

II Dimensions of 30 degrees involute splines with 16 teeth. Fitting (internal), shaft (external). Dimensions of 30 degrees involute splines with 24 teeth. Fitting (internal), shaft (external). III Dimensions of 30 degrees involute splines with 36 teeth. Fitting (internal), shaft (external). Measurement of involute splines with 6, 10, 16, 27, 36 teeth, on shafts.

SURFACE TREATMENT.

Wear Resistant Coatings, by J. E. Jackson. (*J.S.A.E., U.S.A., Vol. 47, No. 1, July, 1940, p. 55*).

The problem of scratching or scuffing of Diesel engine cylinder liners during the run-in of the engine may be largely eliminated through a caustic-sulphur treatment for the honed liners before assembly. Through the various properties of the caustic-sulphur treatment, the run-in is given ample opportunity to produce the most favourable wear-resistant coating which the liner material is capable of forming. As a small amount of surface is worn away, a new layer of the wear-resisting coating will be formed in the next reciprocations of the piston. Newly assembled Diesel engines require a run-in before being

placed in service to bring about a "mating" of all bearings. The difficulty of lubricating the smooth honed liner bore during the period of structural change makes "scratching" or "scuffing" imminent during run-in. Surface treatment is no cure-all and its use does not permit less rigid specifications of lubricating oil and liner materials.

(*Communicated by D.S.R., Ministry of Aircraft Production*).

Recording Surface Finish. (*The Tool Engineer, August, 1940, Vol. IX, No. 4, p. 18*).

The Brush surface analyser provides topographic charts of the surfaces of finished parts accurate to less than one micro-inch. The pickup arm contains a piezo-electric crystal actuated by a sapphire needle or tracer point, which has a spherical radius of .0005 in. The positioning shoe rides over a relatively large area of the surface under test, establishing a reference level for the tracer point and supporting the weight of the pickup arm. The amplifier supplies all the necessary magnification between the pickup arm and the direct inking oscillograph. Magnification of the surface irregularities go up to 40,000 : 1. The fluctuations of the pen are recorded on a moving paper chart driven with three speeds : Five mm. (approx. $^1/_5$ in.) per second, 25 mm. (approx. 1 in.) per second, 125 mm. (approx. 5 in.) per second, and horizontal magnification 16 times, 80 times, 400 times.

WELDING, BRAZING.

Spot Welding of Aluminium and its Alloys, by "Agricola." (*Sheet Metal Industries, September, 1940, Vol. 14, No. 161, p. 992, 8 figs.*).

The physical and chemical characteristics of aluminium exercise the most important effects on the technique, while the mechanical and metallurgical properties determine the strength, and hence utility, of the resulting weld. Physical properties of aluminium and its alloys, compared with other metals. Schematic sketch showing path of welding current when sheets are too "springy" or ill-fitting, or when pressure is insufficient. Influence of current on strength of spot welds in typical alloys. Effect of time on shear strength. Effect of tip load on shear strength of spot welds. Variation of required tip load with thickness of sheet. Typical cycles of "programme control." Electrode materials. Schematic effect of conical tip on the pressure distribution across a spot weld.

INDEX TO ADVERTISEMENTS

Research Department: Production Engineering Abstracts

(Edited by the Director of Research)

ANNEALING, CASE-HARDENING, TEMPERING.

Nitriding of Steels, by F. W. Haywood. (*Wild-Barfield Heat-Treatment Journal, September, 1940, Vol. IV, No. 26, p. 11, 2 figs.*).

The introduction of nitrogen into steel is a process of extreme importance in industry to-day. Attention will be confined exclusively to pure nitrogen case-hardening using ammonia, and in particular to the practical aspects of commercial nitriding. The steels used for commercial nitriding are special alloy steels. These fall into three main groups—(*a*) Nitriding steels which contain one or more elements that form nitrides readily, such as aluminium, chromium or vanadium. The carbon content varies between 0.2 to 0.5%. These steels are the " Nitralloy " steels; (*b*) austenitic steels—special attention is required to the preparation of the surface of such steels prior to nitriding; (*c*) tool and high-speed steel. The method adopted in most cases is that using molten cyanide baths. Nitralloy steels may be forged at 1050° to 1200°C. quenched from the proper hardening temperature and tempered at 620° to 730°C. It quite often happens that certain portions of an article have to be protected against nitriding, and there are a number of methods available for this, which may be summarized briefly as follows: (*a*) Use of a solder containing 80% lead and 20% tin; (*b*) tin plating to a thickness of approximately 0.001 in., followed by heating at 500°C. for one and a half to two hours; (*c*) use of powdered tin as a suspension in a polymerized oil; (*d*) nickel plating which must be reasonably thick to give adequate protection; (*e*) a mixture of tin oxide and shellac or tin oxide and glycerine; (*f*) a paste consisting of finely powdered lead and tin in a suitable vehicle; (*g*) sodium silicate and chrome ore or sodium silicate and whiting; (*h*) copper plating, the nitriding process itself, nitriding furnaces, advantages of the nitriding process.

Surface-hardening Machine. (*Engineering, September 20, 1940, Vol. 150, No. 3897, p. 227, 7 figs.*).

The Shorter surface-hardening machine has been designed for hardening spur gears, bevel gears, single and double helical gears, and straight surfaces. The machine is made in two standard sizes, the largest having a tank 8 ft. 9 in. long by 4 ft. 4 in. deep by 3 ft. 6 in. wide. The smaller machine has a tank 6 ft. 10 in. long by 3 ft. 4 in. deep by 3 ft. 6 in. wide. Work up to 5 cwt. in weight can be supported between centres. The possibilities of the new machine and details of its construction are indicated.

BELTS AND ROPES.

Selection of V-Belts. (*The Machinist, October 19, 1940, Vol. 84, No. 35, p. 633, 1 fig.*).

Correction factors—belt-contact arcs. Horse-power rating of V-belts. Formulas to use. Service factors.

COMPRESSED AIR.

Pneumatic Circuits for Controlling and Operating Machine Cycles, by *L. A. Ward.* (*The Machinist (I), October 12, 1940, Vol. 84, No. 34, p. 344E, 1 fig.*). (*II*) *October 26, 1940, Vol. 84, No. 36, p. 360E, 3 figs.*).

I) Control circuit for sticker.

(*II*) Clamping fixture control. Sequence control. Riveting machine circuit.

JIGS AND FIXTURES.

Jigs and Fixtures—how they are used in Oxy-Acetylene Welding, by John Haydock. (*Sheet Metal Industries, October, 1940, Vol. 14, No. 162, p. 1111, 6 figs.*).

Clamp for angle welds unassembled. Clamp for use on tubes, flanges, etc · Clamp for tubes, etc., unassembled. The basic requirements of a well-designed welding jig may be listed as follows—(1) Simplicity, (2) convenience, (3) visibility, (4) rigidity, (5) durability, (6) heat control, (7) protection of work, (8) clamping pressures, (9) cost, (10) storage facilities. The jigs themselves may be roughly divided into three classes—stationary, hand-operated, and power-operated. Power, either electric or pneumatic, is frequently applied to the same kind of jig that is hand-operated in its simpler form.

KINEMATICS.

Harmonic Motion Cam with Flat-footed Follower, by W. Richards. (*Machinery, October 17, 1940, Vol. 57, No. 1462, p. 63, 7 figs.*).

The particular type of cam under consideration in this article imparts to the follower a composite motion made up of portions of simple harmonic motions of varying amplitude. The construction of the cam profile. The technical design of the cam. Initial steps in the design of a harmonic cam involve a preliminary layout and the calculation of proportions. Diagrams for determining lift values during flank arc operation (acceleration period). Diagrams for determining lift values during nose operation (retardation period). Harmonic cam with dwell period at full lift. Design of the flat-foot follower—pressure angle considerations.

POLISHING, LAPPING, HONING.

Reducing the Cost of Polishing, by Henry R. Power. (*Machinery, October 24, 1940, Vol. 57, No. 1463, p. 100, 3 figs.*).

High-polishing costs are due not so much to incorrect methods of performing the actual operation as to the selection of the wrong polishing materials and to unsatisfactory practice in setting up the wheels. Preparation of the glue. Coating the wheels. The drying process. Grit size of aluminium-oxide grain for polishing operations.

MACHINING WITHOUT CHIPS, PRESSING.

The Use of Rubber in Press Work. (*Aircraft Production, October, 1940, Vol. II, No. 10, p. 323, 10 figs.*).

One of the most important developments resulting from the quantity production of aircraft has been the increased use made of rubber in blanking and forming light-alloy parts. The use of rubber for press work has a number of advantages over hardened steel dies, not the least being speed and economy in the manufacture of tooling equipment. Properties of rubber. Hardnesses of rubber. Pressures involved. Use of auxiliary pressure blocks. Limitations of rubber dies.

MANUFACTURING METHODS.

Machining Shells on B.S.A. Acme-Gridley Bar Automatics. (*Machinery October 3, 1940, Vol. 57, No. 1460, p. 9, 6 figs.*).

Methods employed in the production of ammunition for the Bofors anti-aircraft gun.

The Working of Aluminium Alloys. (*The Machinist, October 12, 1940, Vol. 84, No. 34, p. 617, 14 figs.*).

History of aluminium. Aluminium-base alloys. Physical constants of pure aluminium. Sand-casting alloys. Die-casting alloys. Wrought alloys. Hot forming. Cold forming. Impact extrusion. Spinning. Hammering. Heat-treatment of aluminium alloys : Annealing, solution treatments, quenching. Precipitation treatments. Machining practice for aluminium : Turning and boring. Screw-machine work. Planing and shaping. Milling. Drilling, Reaming. Speeds and feeds for aluminium alloys. Threading, Tapping, Filing. Sawing. Grinding. Characteristics of wrought and cast aluminium-base alloys. Cutting lubricants. Joining practices for aluminium : Riveting, soldering, torch welding. Wheels recommended for grinding aluminium alloys. Arc Welding. Resistance welding. Brazing. Finishes for aluminium. Mechanical finishes. Chemical finishes. Typical polishing procedures for aluminium. Electrolytic finishes. Paints and lacquers.

The Airspeed Oxford, by Wilfred E. Goff. (*Aircraft Production, October, 1940, Vol. 11, No. 10, p. 313, 24 figs.*).

Part 1. A twin-engined trainer aircraft of advanced design : Works processes as practised by "Airspeed" (1934), Ltd. General arrangement and data for the Airspeed Oxford. Spar assembly. Building up the spar booms. These are formed to the required curvature in jigs of the type shown in the foreground. One of the gluing jigs in which booms and soldiers are assembled. Wooden wedges are used to hold the booms in position. Improved wood wedge-pieces being glued in position under a double hydraulic press. Both ends are dealt with simultaneously. Spindling operations in progress in the woodmill on a centre section spar. A Sagar machine is being employed. Two large jigs in which the assembled spars are drilled for the main plane attachment lugs and the fuselage pick-up fittings. Assembly of fittings. Second stage of assembly. Applying the skin. The wood detail shop. Fin and tail-plane. Elevator assembly. The rudder.

MEASURING METHODS.

Modern Measuring Instruments and the Principles of their Design, by Dr. Geo. Schlesinger. (*The Journal of the Institution of Production Engineers, September, 1940, Vol. XIX, No. 9, p. 317, 46 figs.*).

In this article will be considered the refinements of fits and limits, the possibilities of accurate measurement, the character and range of the necessary instruments, and the formulae for calculating the degree of magnification. The measuring system may be based on (1) mechanical means, (2) optical means, (3) micro-comparator gauges, (4) methods of " active " calibration. The N.P.L. differential screw micrometer. The principle of the single multiplying lever. Tubular type indicator with lever and segment and pinion magnification. The passameter external indicating gauge. The passimeter internal indicating gauge. Hirth minimeter. Dial indicator in which the plunger movement is magnified through gearing. The calculations for sensitivity and calibration of precision levels. Sectional view of the Cooke, Troughton & Simms' optical comparator. The magnifying system of the

ultra-optimeter. The principle of the Taylor, Taylor & Hobson two-hundred profile projector. Diagram showing how a parallel light beam inclined at the helix angle is used for thread projection. Cutter head for Gleason hypoid gear checked with the aid of the profile projector. Optical alignment tester. Sighting telescope and collimator. The auto-collimator. Auto-collimator and reflecting mirror for straightness tests. The auto-collimator and the method of testing a surface therewith. Probable error of measurement. The block reflector. The optical square. The Sheffield visual gauge. The electro-limit gauge. Solex pneumatic micrometer. Special equipment for checking snap gauges with the Solex pneumatic micrometer. Control of work size during machining. The Precizer automatic work-size controller for grinding machines. Diagrams illustrating the operation of the Heald sizing device for internal grinding. Thread grinding a milling cutter with a multi-rib wheel. Method of truing multi-rib thread grinding wheel. Pantograph method of truing a single-rib thread-grinding wheel. The gear tooth profile is generated by a plane surface on the grinding wheel. Formed wheel for gear tooth grinding. Formed wheel for spline-shaft grinding. Tendency nowadays to avoid the separation of machining and measuring, and to combine the controls for the cutting tool or grinding wheel with the measuring apparatus, in order to relieve the operator of responsibility for size.

SMALL TOOLS.

Machining with Single Point Tools. (M. Kronenberg, *Engineering, Vol. 150, No. 3898, September 27, 1940, pp. 259/260.*)

The author investigates cutting speed as a function of (1) tool life, (2) depth of cut and feed per revolution. Cutting force is expressed as a function of chip cross sectional area and cutting pressure as a function of depth of cut and feed.

If P_t = h.p. at cutting edge,
V = cutting speed in ft/mins.
F = cutting force in lb.,
A = chip cross sectional area in sq. in.,
we have

$$V = \frac{33000 \times P_t}{F}$$

The author expresses F in terms of A by means of the equation

$$F = C_p \times A^r,$$

where C_p and r are material constants. Using a logarithmic diagram, it is thus possible to draw a series of constant h.p. lines connecting V and A (or F). An alternative expression for V for constant tool life is given as

$$V = C_v \times A^{-s},$$

where
C_v = constant depending on material, tool, tool life and cutting fluid,
s = a material constant.

Using this equation, a second series of lines can be plotted, connecting V and A (or F) along which the tool life is constant. An increase in V produces an increase in tool h.p. and a reduction in tool life. The two sets of curves, however, cross at an angle, the lines of constant tool life making a smaller angle with the A axis (abscissa). From these diagrams the author draws a number of conclusions, of which the main are summarised below. It is assumed that the original adjustment is normal. (1) Increasing cutting speed at constant tool life leads to a considerable reduction in volume of material removed per minute and is thus unproductive, and the machine is not used to full capacity ; (2) decreasing cutting speed at constant tool life overloads the machine;

(3) increase in cutting speed at constant tool h.p. causes a rapid diminution in normal tool life and necessitates the use of special tools (cemented carbide). There is a small reduction in rate of removal of material, but the considerable reduction in cutting force is an advantage (less deflection, greater accuracy, smoother finish); (4) decrease in cutting speed at constant tool h.p. increases tool life and rate of removal of material. The disadvantage is the increase in tool pressure.

Development in Cutting Tools. (*Engineer, Vol. 70, No. 4420, September 27, 1940, p. 201*).

A new Grade 80 Stellite has recently been introduced. The difference in its composition enables it to machine the higher tensile steels. Grade 80 Stellite is not supplied as bar stock, but only in the form of finished tool bits, tipped tools, milling cutter blades and special formed tools, both rectangular and circular in shape. Stellite Grade 80 is also used in the form of taper and parallel hand and machine reamers when used on the lighter alloys of the duralumin group. In such cases the cutting portions of the reamer only are made from Stellite, and the teeth are ground straight into the Stellite. On account of its inherent hardness no heat treatment is required.

Grinding Carbide Cutters, by Fred W. Lucht. (*The Machinist, October* 12, *1940, Vol. 84, No. 34, p. 603, 2 figs.*).

Size and placement of the tooth rest depends on the type of machine used, size of the milling cutter, tooth spacing, and rake angle of the cutter. Best practice is to measure the indicator drop $^1/_{16}$ in. back of the cutting edge. Table on clearance on milling cutters.

Diamonds for Truing Grinding Wheels, by Leo Gluck. (*The Machinist, October 5, 1940, Vol. 84, No. 33, p. 587*).

Knowing the face width of the grinding wheel and the grits per inch, the most economical diamond size for truing operations can be obtained from a chart shown. Economic diamond weights for truing grinding wheels.

SURFACE, SURFACE TREATMENT.

How Should Engineers Describe a Surface? by O. R. Schurig. (*Mechanical Engineering, October, 1940, Vol. 62, No. 10, p. 703, 18 figs.*).

Review of the surfaces of a number of manufactured parts and the requirements they have to meet: (1) Bearing surfaces operated with oil; (2) rubbing surfaces—dry—collector surface; (3) stationary contact surfaces and joints. Surfaces having the same over-all R M S roughness. Surfaces for other applications. Summary of questions. Conclusion: The geometrical characteristics of a surface profile are so numerous that the shape of a surface cannot be adequately described by a single parameter of its profile.

WELDING, BRAZING.

Low Temperature Welding of Cast Iron, by H. Klopstock. (*The Welding Industry, September, 1940, Vol. VIII, No. 8, p. 218, 8 figs.*).

Appearance of blowholes. Welding. Brazing. Hard soldering. The theory of this new process is that an integral bond between two metals on the soldering principle is possible without having to melt the parent metal. For the correct bond to take place it is important that the soldering metal "floods" the surface of the parent metal. Fields of application. Machine tool applications. Repair of a lathe. Reconditioning a motor cylinder. Using the new method with about 850° working temperature, and making use of the capillary

F

attraction between the molten metal and the non-molten parent metal, the structure of the parent metal will be kept unchanged, and for this reason the machinability of the adjacent parts, as well as of the deposit, will be satisfactory.

Workshop Inspection of Welds. (*The Welding Industry, October, 1940, Vol. VIII, No. 9, p. 244, 26 figs.*).

High quality electrodes. Effect of moisture on electrodes. Current and voltage values. Minimum current values. Voltage values or arc length. Penetration and undercut. Weld size and contour. Vertical welds. Nick break test.

Pulsation Welding, by H. C. Cogan and R. S. Pelton. (*The Welding Industry October, 1940, Vol. VIII, No. 9, p. 249, 1 fig.*).

Pulsation welding is a resistance welding method which is being increasingly adopted in the U.S.A. The advantages especially with spot and profection welding, on small as well as large work, are : (1) Increased electrode life ; (2) thicker material can be welded in production than was practical before ; (3) thicker material can be welded with the same equipment ; (4) better welds are produced in many cases ; (5) any tendency of the weld metal to " spit " is noticeably reduced by interrupting the current flow. Improved appearance of welds. Machine used for pulsation welding of car parts. Spot welding frame assemblies. The welding technique pulsation spot welds com prises : tip diameter (in.) ; static pressure (lb. amp.) ; cycles on, off ; number of pulsations ; material. Pulsation welding aluminium.

The Arc-welded Fabrication of Machine Tools. (*Engineering, October 4, 1940, Vol. 150, No. 3899, p. 265, 5 figs.*).

Five examples of arc-welding fabrication are illustrated. They cover a wide range and, in most instances, have been in service for sufficiently long periods to prove the soundness of the method as regards durability. A frame for a punching machine with a capacity for punching holes 2 in. in diameter in mild-steel plate ⅞ in. thick. A bed for a reaming machine in which great rigidity is required. The bed is 6 ft. 4 in. long by 3 ft. 6 in. wide by 2 ft. 9 in. high, and weighs 24 cwt. Housings for plate-bending rolls of plates up to 20 ft. wide by 1¼ in. thick. A flat surface stiffened by ribs is shown, being a table 14 ft. in diameter by 14 in. deep, which was required for the conversion of an existing slotting machine.

INDEX TO ADVERTISEMENTS

Research Department: Production Engineering Abstracts

(Edited by the Director of Research)

NOTE.—*The addresses of the publications referred to in these Abstracts may be obtained on application to the Research Department, Loughborough College, Loughborough.*

ANNEALING, CASEHARDENING, TEMPERING.

Hard Facing to Resist Wear. (*Metallurgia, Germany, Vol. 22, No. 130, August, 1940, p. 133*).

Appreciation of the value of hard facing has greatly increased in recent years, largely as the result of the development of many processes of applying metals and alloys or treatments to surfaces which increase resistance to wear, corrosion, or both. Hard surfaces may be produced on metal parts of suitable composition by means of various forms of heat-treatment, such as carburising, nitriding, induction hardening, flame hardening, etc., by metal spraying, by electro-deposition of chromium or other hard elements, by the fusion welding of hard alloys, or the cementing of special sintered carbides. Zeyen gives five groups of hard-facing materials, in order of increasing wear resistance, alloy steels containing up to approximately 20% of alloy constituents, iron base alloys containing over 20% of alloying constituents, non-ferrous cobalt chromium-tungsten alloys, crushed tungsten carbide which, after welding, is embedded in a steel binder, and cast tungsten carbide inserts. The order of their toughness is approximately the opposite of wear resistance. According to Le Van most steels can be readily hard faced, but those containing 0.50% carbon and over usually must be heat treated, and the hard facing of high speed steel is unsatisfactory. Low alloy and stainless steels, grey cast iron, alloy cast iron, and nickel base alloys are also hard faced successfully. Brass, bronze, copper, and aluminium alloys are difficult to hard face, because of their relatively low melting points. Hard facing metals and alloys are applied by either electric or oxy-acetylene welding processes, though non ferrous alloys are best applied by means of the oxy-acetylene process. With the metallic arc, a certain amount of inter-alloying is unavoidable, although it can be kept at a minimum through careful control.

(*Communicated by D.S.R., Ministry of Aircraft Production*).

COMBUSTION, FURNACES.

Electrical Melting and Heat-treatment Furnaces in Aluminium Works, by F. Essmann. (*Metallwirtschaft, Germany, May 31, 1940, p. 447*).

All types of furnaces are discussed in relation to various kinds of alloys.

(*Communicated by the B.N.F. Bulletin*).

COOLANTS, LUBRICANTS.

TheStat ic Coefficient of Lubricated Surfaces, by A. Fogg and S. A. Hunwicks. (*Engineer, Vol. 170, No. 4420, September 27, 1940, p. 206, and No. 4421, October 4, 1940, p. 214*).

When determining the coefficient of static friction with machines of the Deely type, everything depends on the method of cleaning adopted for preparing the standard surface. The authors experimented with hard steel surfaces which were cleaned with abrasives. Under these conditions which correspond

to minimum oiliness. the coefficient of friction was of the order of .58 and represents an upper limit. The following table gives the friction coefficient in the presence of various lubricants.

LUBRICANT	Coefficient of friction
Benzene	.48
Alcohol	.43
Trichlorethylene	.33
Glycerin	.20
B.P. paraffin	.18
Plain lubricating oil ...	.15
Synthetic lubricating oil ...	.14
Graphited lubricating oil ...	.13
Extreme pressure lubricants .	.10
Oleic acid	.08

It is interesting to note that the coefficient of friction obtained in this manner is only very slightly affected by temperature over the range 20° to 100°C. In several instances a rise in temperature increased the friction. As is well known, the addition of oleic acid or rape oil to mineral lubricating oil improves the oiliness. It is generally held that the full benefit is obtained with relatively small additions. The authors' experiments, however, show that, although the first small additions produce a relatively greater effect, the coefficient of static friction is reduced progressively with addition, the lowest value being obtained with 100% rape or oleic acid. The work is being extended to cover other combinations of metal.

Notes on Lubrication : Wear, by D. Clayton, B.Sc. (*Power Transmission, November 15, 1940, Vol. 9, No. 106, p. 439*).

Wear of a part is its undesired gradual change in dimensions in service under frictional pressure." Wear and friction. Fluid film conditions. Running-in. The mechanism of wear. Addition agents for oils.

Cutting Fluids for Nickel Alloys and Nickel-containing Steel, H. L. Moir and O. W. Boston : "A New Study of Cutting Fluid Recommendations." (*Soc. of Automotive Eng., 1940 ; Preprint, p. 8*).

A Committee, affiliated with the American Society for Metals, formed in 1937, has operated along three main lines, viz. : (1) the preparation and distribution of a questionnaire designed to ascertain current practice in the use of cutting fluids, (2) the preparation of a machinability rating chart for metals in common use, and (3) the correlation of data obtained under (1) and (2) and the preparation of a table of cutting fluid recommendations. The results of returns made under (1) were presented in an article entitled "Cutting Fluids. Their Use Surveyed." (*Metal Progress, June, 1938*). The machinability rating chart was based on the turning of S.A.E.1112 cold-drawn steel at a cutting speed of 180 ft. per min. as being 100%. Table I is the final rating as adopted by the Committee. The final section of the investigation dealt with the compilation of a table of recommendations. The chart developed shows fluids recommended for use in eleven cutting processes, arranged in order of decreasing severity, for each of the groups of materials shown in Table I. Recommendations on cutting fluids are advisedly confined to types of fluid rather than specifying individual products, and it is emphasised that there may be considerable variations in the effectiveness of two fluids of the same

type, on a given machining operation, due tc different manufacturing methods used in production of individual cutting fluids of the same class. The following general notes are added : Sulphurised oils have a tendency to stain certain non-ferrous metals, such as copper and its alloys. In the machining of aluminium, cutting oils and emulsions are sometimes diluted with kerosene with satisfactory results. Magnesium and its alloys are usually machined dry with powdered asbestos available to smother flames if started. Emulsions or water should not be used. If a cutting fluid is used, mineral seal oil is recommended. Generally speaking, mineral lard and sulphurised oil mixtures of low sulphur percentages are interchangeable. For best tool life, cutting fluids should be applied in large quantities at high velocities and at low temperatures.

FOUNDRY, MOULDING.

Centrifugally Cast Gear Blanks. (*Machinery, October 31, 1940, Vol. 57, No. 1464, p. 117, 5 figs.*).

Production of gears for Ford light and heavy motor vehicles. Turntable for centrifugal casting of gear blanks for the Ford Motor Co. Placing a cope of a casting mould ready for pouring. Cross-section of a typical mould showing arrangement of cores. Cross-section of a mould used for differential ring gears on tractors.

GEARING.

Intermittent Rating of Gear Drives—II, by A. B. White. (*Power Transmission, November 15, 1940, Vol. 9, No. 106, p. 432, 3 figs.*).

The various conditions of duty covered by intermittent rating can be classified under the following headings : (1) The transmission of steady load for working periods of less than twelve hours. (2) The transmission of steady loads for working periods of more than twelve hours without any overloads. (3) The transmission of a steady load for periods more than twelve hours in combination with an overload greater than the steady load which is transmitted for a fraction of the total working period. (4) The transmission of a steady load for periods of less than twelve hours in combination with an overload acting for a fraction of the total working period. (5) The transmission of a steady load for twelve hours combined with overloads. In the above classifications the term "overload" does not include overloads of a very momentary nature, since any pair of gears is capable of sustaining 90% overload on "strength" and 155% overload on "wear" for periods not exceeding three seconds.

Direct Method of Designing Gears for Strength. (*Machinery, November 14, 1940, Vol. 57, No. 1466, p. 179*).

Spur gear velocity range classification and permissible errors for each class. Spur gear design—examples illustrating application of direct method. Design of helical and herringbone gears. Straight-tooth and spiral bevel gears. Worm gears.

JIGS AND FIXTURES.

Fixtures for Production, by C. C. Street. (*The Machinist, November 9, 1940, Vol. 84, No. 38, p. 700, 4 figs.*).

Properly placed dial indicators afford a convenient method of comparing work dimensions to those of an accurate master. Point of reference needed. Practically any complex measuring problem can be solved with a properly designed unit.

KINEMATICS.

Pneumatic Circuits, by L. A. Ward. (*The Machinist, November 9, 1940, Vol. 84, No. 38, p. 376E, 3 figs.*).

For controlling and operating machine cycles—III. Tray-shaking arrangement. Marine drive gear shift. Pressure control for clinching machine.

MACHINE—ELEMENTS.

Fatigue of Helical Springs, by R. R. Tatnall. (*Mechanical World, November 22, 1940, Vol. CVIII, No. 2812, p. 373, 6 figs.*).

An explanation for many cases of premature breakage. Dimension specifications. Illustration of spring showing typical fatigue failure. Induced vibration of helical springs. Graphical representation of working cycle. Variations of working cycle. Results of fatigue tests. Range of endurance limit in commercial oil-tempered spring wire of 0.148 in. dia. Effect of physical properties of materials. Comparison of fatigue properties of material with fatigue requirements of spring.

MACHINE-TOOLS, MACHINING.

The Rebuilding of Old Machine Tools for War Requirements, by Geo. Schlesinger. (*Machinery, November 7, 1940, Vol. 57, No. 1465, p. 147, 3 figs.*).

A lathe, twenty-five years old, which has been rebuilt to permit of high-speed turning. A sectional view showing the spindle mounting and back gear arrangement. Spindle speeds of lathe before and after rebuilding. Surface speeds on work-pieces of various diameters. A carbide-tipped tool which has been cracked owing to the spindle stopping while a cut was being taken. The cost of rebuilding the machine, which included new gears, a balanced cone pulley, a tool post, and improved lubrication and foundations, amounted to about £50 and the work was completed in six weeks altogether. A new lathe of this size of 22-in. swing, admitting 5 ft. between centres, with an 8 to 10-h.p. motor, and weighing 3.6 tons, cannot usually be obtained under present conditions in less than forty weeks and costs at least £1,100.

Auxiliary Supports for Machine Tools, by Fred Horner. (*Machinery, November 21, 1940, Vol. 57, No. 1467, p. 207, 24 figs.*).

Horizontal boring machines. Method of adjustment to compensate for wear of nut on the outer standard of a boring machine. Outboard bearing and column employed on an Asquith boring machine. Outboard bearing for turbine boring machine. Hinged tie-bar for connecting the tall columns on a Harvey boring machine. Drilling machines: Auxiliary support for drill-head by guide bars. Gear cutting machines. Arbor bearing support for a David Brown worm-wheel generator to which vertical and swivelling motions can be imparted. Arbor support column for a Holroyd gear cutter. Girder tie, arbor bearing, and swivel-top column of Wallwork hobber. Arbor drive and support arrangements on Sunderland 12 in. gear generator. Outboard bearing for work-arbor on pinion-cutter type generator. Ram stays for Sunderland gear planers. Method of adjusting bush and turret steady-bars provided on an American turret lathe. Table support for a Butler shaping machine. Table support on a Churchill-Redman universal shaper.

Machining Monel Metal, Nickel, and Inconel. (*Machinery, October 31, 1940, Vol. 57, No. 1464, p. 123, 13 figs.*).

The machining of Monel metal, nickel, and Inconel can be carried out on much the same lines as for mild steel. High-speed tools should be used, and generous lubrication is generally essential. Turning. Cutting-off operation. Drilling. Reaming. Tapping. Milling. Threading. Screwing. Grinding.

The Production of Machine Tools. (*Machinery, November 21, 1940, Vol. 57, No. 1467, p. 197, 9 figs.*).

Typical operations involved in the fitting and erection of grinding machines at the works of A. A. Jones & Shipman, Ltd. Special spirit level for checking the alignment of the bed ways. Method employed for checking the parallelism of the upper and lower surfaces of the table. Method of checking the table and grinding-head slide facing in the transverse direction. Typical inspection report for a bench grinder. An alignment chart, similar to that shown herewith, is supplied with each grinding machine sold.

Grinding Slideways, by T. Smith. (*Machine Shop Magazine, October, 1940, Vol. 1, No. 10, p. 45, 6 figs.*).

The slideway grinder. The vertical fine feed is indexed to give a fine feed down to .0001 in. and the cross feed to give a traverse of .00025 in. Setting for angular work. Grinding wheels and procedure. Angular setting of wheelhead. Auxiliary side-grinding attachment in use paralleling the back face of a column. Grinding the upper face of a machine table while in position on the previously ground bed. Diagram showing several jobs that can be done on the slideway grinding machine.

Contour Sawing, by H. J. Chamberland. (*The Tool Engineer, October, 1940, Vol. IX, No. 6, p. 15, 3 figs.*).

Contour sawing will render a valuable service to industry at this time through relieving other metal-cutting tools of the necessity of removing waste metal. The introduction of $^1/_{16}$ in. saw widths make it a simple matter to navigate through complicated outlines and extremely small radii. A mechanically minded and attentive operator can soon produce work which previously required the highest skill that only comes with years of practical experience. Making templates and cams. Savings in cam production.

MANUFACTURING METHODS.

How to Make Artillery Cartridge Cases, by Frank J. Lerro. (*The Machinist, November 23, 1940, Vol. 84, No. 40, p. 761, 25 figs.*).

Many improvements have been made in the manufacture of artillery cartridge cases at Frankford Arsenal. The 75 mm. cartridge case is offered as a typical example of the tool development. Some interesting illustrations are selected. They show : a dial-feed press is used for the first redraw ; a 70-ton pressure is required, but an oversize press is used ; the case is hand fed into the die because the length of the stroke renders dial feed unnecessary ; a close-up of the set-up for the first trim shows how the case is held and sheared ; heading and indenting are performed simultaneously in a dial-feed hydraulic press ; the case is forced downward into the tapering die and then freed by means of a knockout ; machining the head and primer hole is done in a four-spindle machine and includes drilling, rough and finish reaming ; with the base gripped in a collet, the case is trimmed to length in a set-up arranged for handling two pieces simultaneously.

How to Machine 75-mm. Shell, by Charles Grazioso. (*The Machinist, November 2, 1940, Vol. 84, No. 37, p. 669, 18 figs.*).

The shell forging is made of SAE X1340 steel. Yield point 55,000 lb. per sq. in., elongation in 2 in., 15% ; reduction of area, not less than 30%. The completely machined shell weighs 10.97 lb. empty as against 20 lb. maximum for the forging. Special mandrel for centring. The nose of the 75 mm. shell is cold formed in a crank press while held in a vertical collet. Finished on multi-spindle machine. Fixture for inspection after rough and finish turning to determine the degree of runout. Very clear drawings of all operations.

The Airspeed Oxford, by Wilfred E. Goff. (*Aircraft Production, November, 1940, Vol. II, No. 11, p. 350, 17 figs.*).

Production of the sub-assemblies and final erection of the main planes.

Comments on German Types, by Bruce Foster. (*Aircraft Production, November, 1940, Vol. II, No. 11, p. 347, 13 figs.*).

The design of enemy aircraft examined from the production viewpoint. Staggered joints have been used in plating the fuselage of the He 111K. The Heinkel fuselage frame is made in three parts. They are of Z section and joined to the stringers only and not to the skin. In Ju 87 fuselage construction the frames are set down on the skin and a curved angle bracket is used to connect stringer and frame. The riveted longitudinal joint of two angles can be seen, also the close spacing of the lower stringers. A Mercedes-Benz DB 601A engine installed in the nose of the Me 109 single-seater fighter on the massive engine mounting seen. The airscrew is a three-bladed metal V.D.M. electrically operated feathering type. Pitch is infinitely variable by a manually controlled switch, but the airscrew is not constant speed. Messerschmitt fuselage construction makes use of flanged-up plates and two longitudinal joints. Much riveting of frames to skin is avoided, and there is no attachment between stringers and frames. Self-aligning ball joints are typical of Junkers construction. The Me 110 is the latest design of the various types reviewed. This aircraft is aerodynamically very clean, and the attainment of high speed has been considerably aided by flush riveting and a smooth external finish. The view of the Mercedes-Benz DB 601A engine shows the bank of 12 Bosch injection pumps in the vee between the cylinders.

The Production of a Pressed Steel Bucket. (*Machinery, November 7, 1940, Vol. 57, No. 1465, p. 151, 12 figs.*).

Determination of blank diameter. Tool for producing bucket blanks. Planning the operations. Blanking tool. Initial drawing and first re-drawing tool. Second and third re-drawing tools. Final drawing and forming tool. Curling or wiring tool. Operations on alternate design of bucket. Flange flattening tool. First forming tool for bending the bead. Annealing.

MATERIALS, MATERIAL TESTING.

Some Observations on Brass Season-cracking, by R. G. Johnston. (*Sheet Metal Industries, November, 1940, Vol. 14, No. 163, p. 1197, 3 figs.*).

Season-cracking has received a great deal of study and discussion from metallurgists. It is true to state that at once the phenomenon is not understood, although empirical knowledge enough is available to reduce the havoc it causes. True service conditions. The network type. Ammonia or ammonia salts? Effect of free oxygen. It seems that there can be little doubt that the whole of the network type of cracking is a corrosion. Programme of further tests.

Adhesion of White Metal Linings in Bearings. (*Engineering, Vol. 150, No. 3898, September 27, 1940, p. 250*).

The first essential for good adhesion is that the shell must be given a complete and continuous coating of tin before the white-metal lining is poured. It is pointed out in this connection, however, that cast iron and certain alloy steels are difficult to tin, steels containing more than 0.25% of nickel or more than 0.6% of manganese being particularly troublesome. The most dependable method in such difficult cases, it has been found, is to copper-plate the shell before tinning. Degreasing should follow as soon as possible on the turning of the shell.


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While copper, bronze, brass or mild-steel shells may be tinned relatively easily, it is pointed out that the degreasing treatment should be conducted in as thorough a manner as with cast iron or alloy-steel shells. They are then pickled to provide a reactive surface. The temperature of the tinning bath, in the case of the copper and copper-alloy shells, should be at a maximum of 260°C. in order to avoid the formation of excessive amounts of inter-metallic alloy. The time of immersion should be up to two minutes. For mild-steel shells, the tin bath should be at a temperature of 400°C.

The Rolling of Magnesium, by Professor W. R. D. Jones, D.Sc., and L. Powell, B.Sc. (*Sheet Metal Industries, November, 1940, Vol. 14, No. 163, p. 1169, 3 figs.*).

The effect of cold work and subsequent annealing on magnesium. Plan of the mould. Hot rolling of the slabs to 10 gauge. Rolling of the sheets from 10 to 16 gauge. Mechanical tests. Discussion of results. The mechanical properties of sheets hot rolled in different directions from 10 to 16 gauge. The effect of annealing on the mechanical properties of sheets hot rolled in different directions from 10 to 16 gauge. The effect of varying the method of rolling. Microscopical examination and grain-size. Microstructure of cold-rolled and annealed sheets.

MEASURING METHODS, APPARATUS.

O.M.T. Optical Flats. (*Engineering, November 15, 1940, Vol. 150, No. 3905, p. 385*).

Made by Messrs. Optical Measuring Tools, Ltd., Slough. If a perfectly flat testing surface is imposed on a curved one, curved interference rings will appear. Anywhere on the innermost ring, i.e., that near the point of contact the air space between the two surfaces will have a thickness equal to half the wavelength of the light used, i.e., of the order of 0.00001 in. At the second ring the thickness will be equal to one wavelength, at the third equal to 1.5 wavelengths, so that the number of bands in a given length, multiplied by 0.00001, will give the thickness at the deep end of the wedge of air, or, in other words, the total departure of the surface being tested from a true plane. If there were, say five bands visible, the height of the spherical segment bounded by the outermost band would be 0.00005 in. The application of an optical flat to a flat but sloping surface would indicate by the parallel and equidistant interference bands that the surface sloped uniformly over the distance covered by the bands.

Indicating Bore Gauges, by C. C. Street. (*The Machinist, November 23, 1940, Vol. 84, No. 40, p. 748, 5 figs.*).

Deviation of the measuring plane from the axis of the bore is one of the basic types of errors to be considered in bore measuring instruments. A second source of error in bore gauging is the possibility of taking the measurement when the diameter measured is not at right angles to the bore. A curved plunger in a curved slot transfers motion from the contact point down the axis of the bore in the shown type of gauge head. The gauge can be checked by holding it at about 15° off the axis of the bore and observing the minimum reading when slowly swinging the guage.

The Desirability of Acceptance Test Charts. Meeting of the Institution of Mechanical Engineers. (*Engineering, November 1, 1940, Vol. 150, No. 3903, p. 354*).

Acceptance test charts for machine tools. The discussion was opened by Mr.Mark H. Taylor. The first charts, it must be understood, did not legislate for

anything but the minimum acceptable standards. The real point before the meeting was to decide whether the type of chart recently published was desirable and useful. Many shops contained a number of machines of equal capacity but, not infrequently, of different makes. It was not an easy task to load these machines economically if their standard of accuracy varied, whether this loading was done by the foreman or the progress office. A uniform standard of accuracy would remove this disability. The manufacturers ought to welcome a commonly understood technique which assured proper handling of the tool before it was put to use. The charts, however, were intended to cover machines that had been some time in use as well as new ones, particularly valuable function, he submitted, at a time like the present, when old machines were of great value. Mr. Stanier, in the chair, Mr. J. D. Scaife, Mr. J. E. Baty, Mr. A. Powis Bale, Mr. F. Turner, Mr. G. W. Clarke, and Dr. G. Schlesinger agreed generally with Mr. M. H. Taylor's impartial and correct statements.

SHOP AND SHOP MANAGEMENT.

Quality Control, by C. E. Pomnitz. (*The Tool Engineer, October, 1940, Vol. IX, No. 6, p. 24*).

An inspection ticket with a " Stop Operation " tag attached. Tickets which record poor performance are studied and repeated errors are corrected. All materials received are inspected rigidly for conformation to specifications. Never should process inspection be directly under a supervision closely responsible for the manufacture of the product. The process inspector travels from machine to machine, checking the product to specifications. The final inspection organisation functions to eliminate the occasional variant from the set standard of quality. In the manufacture of roller bearings it is essential to maintain proper sizes and definite internal clearances. Races are segregated for size in .0002 in. steps ; rollers are segregated for size in .0001 in. steps and assembled in combinations to produce bearings of proper internal clearances and bearings in which the roller diameter variation does not exceed .0001 in.

The Engineering Method in Management, by A. I. Peterson. (*Transactions of the A.S.M.E., October, 1940, Vol. 62, No. 7, p. 587*).

Professional management in modern industry demands competence and vital direction of a high order, approached only with scientific objectivity. Engineering and economics are the basic tools of the profession. The author reduces the problems inherent in applied economics to four types : The selection, replacement and apportionment of elements of production ; the analysis of optimum enterprise economy ; the rationalisation of the dynamics of specific industries ; and the interpretation and guidance of the trends and adjustments in the parent social environment. The paper indicates the necessity for more critical research and broader training in industrial management.

SMALL TOOLS.

Tap Standards—II. (*The Machinist, November 16, 1940, Vol. 84, No. 39, p. 725*).

A standard for cut and ground thread taps has been approved by the American Standards Association. It includes definitions, markings, working tolerances, as well as thread and general dimensions of American National Form Thread for all sorts of taps, and the American National Form Thread limits.


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Tool Crib Control of Carbide Tools, by Gaylord G. Thompson. (*Machine Shop Magazine, Nobember, 1940, Vol. I, No. 11, p. 56, 7 figs.*).

Cabinet for carbide tools. First copy of tool layout sheet for a coupling. Tools are controlled. Card giving list of tools needed for machining the coupling. Time study procedure. Tool requisition form to be presented to storekeeper.

SURFACE, SURFACE TREATMENT.

How Should Engineers Describe a Surface ? by O. R. Schurig. (*Mechanical Engineering, October, 1940, Vol. 62, No. 10, p. 703, 18 figs.*).

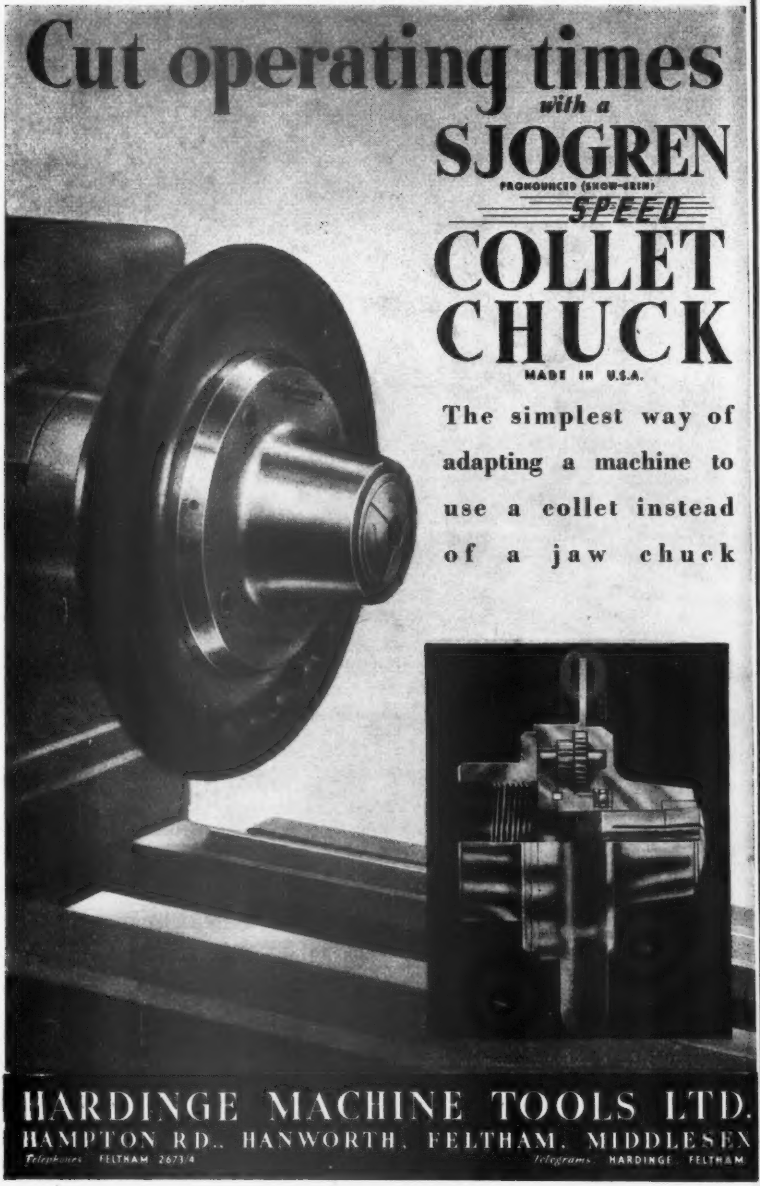
(1) Illustration of some of the types of surfaces in which the General Electric Company is interested, to point out some of their characteristics, and to review the requirements they have to meet. (2) To submit questions for the purpose of establishing what surface characteristics need to be considered as a basis for describing and specifying surface deviations in industry. The scope of the paper is limited to a consideration of three kinds of surface deviations or irregularities, namely, waviness, roughness and flaws. The following review of surfaces of various manufactured parts includes : (1) Bearing surfaces operated with oil ; (2) dry rubbing surfaces ; and (3) stationary contact surfaces and joints. Conclusion : The geometrical characteristics of a surface profile are so numerous that the shape of a surface cannot be adequately described by a single parameter of its profile. The following geometrical characteristics have been suggested in connection with the description of a surface : Maximum height from highest to lowest point ; average height above base line passing through lowest point ; form factor, being the ratio of average height to maximum height above base line ; root-mean-square average height with respect to centre line of profile ; prevailing wave length ; direction of irregularities above or below the prevailing surface contour ; direction of finish marks with respect to co-ordinates of the surface ; available contact area per unit nominal area.

Surface Quality of an S.A.E. 3140 Steel, by O. W. Boston and W. W. Gilbert. (*Mechanical Engineering, November, 1940, Vol. 62, No. 11, p. 785, 7 figs.*).

Tool life, power consumption, and surface finish are of greatest importance, and yet they are not interrelated. Several of the factors which influence surface finish reported upon in this paper are cutting speed, cutting fluids, and the heat treatment of the material cut. Diagram showing operating principle of profilograph. Effect of cutting speed. (S.A.E. 3140 steel ; normalised and annealed, dry). This steel had the following chemical analysis : Carbon 0.42%, manganese 0.69%, sulphur 0.021%, phosphorus 0.017%, silicon 0.17%, nickel 1.41%, chromium 0.61%. The effect of cutting speed. Profilograms for surfaces. (Feed 0.0625 in. per revolution, depth 0.0035 in, vertical X 1000, horizontal X 32). Surface finishes and profilograms for S.A.E. 3140 steel. (Normalised and annealed, dry facing cuts, using feed 0.0625 in. per revolution, depth 0.0035 in., X 11.5). Influence of cutting fluids. Influence of heat treatment. General conclusions.

Anodic Coatings. (*Mechanical World, November 1, 1940, Vol. CVIII, No. 2809, p. 319, 11 figs.*).

Although aluminium oxide is a transparent, colourless material, anodic oxide coatings on commercial aluminium or its alloys may show colour and even a pattern-like structure, which are interesting in a scientific way, and which are of real commercial importance. What anodic coatings look like in section. Thin sections of oxide coating. Thickness of coatings. Abrasions resistance. Electrical breakdown.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Infra-red in Industry, by John Sasso. (*The Machinist, November 23, 1940, Vol. 84, No. 40, p. 741, 5 figs.*).

Infra-red drying has attained considerable acceptance; it is now being used for drying prime and finishing coats on auto bodies, enamel on parts such as steering columns, lacquered surfaces, paint on castings, enamels on die-castings, for softening plastic sheets prior to punching and for baking transformers and armatures. Table on average watt per sq. in. on work. Table on reflection factors of pigments. Table on hardening characteristics of finishes. Material. Baking temperature. Comment.

Use of Clad Metals in Germany, W. Radeker (Germany). (*Metal Progress, Vol. 38, No. 3, September, 1940, p. 292*).

"Cladding" is the term employed for the bonding of a nobler metal to a less noble base. This leads not only to the conservation of strategic materials, but the bonded product may have qualities which are superior to those of either of its constituents.

Considerable use is made of cladding on a steel sheet base, the following metals being used for the covering: Copper, nickel, 18.8 chromium nickel or a special scale and creep-resistant steel.

The most common method of manufacture is by rolling at the welding temperature. Ordinary steel and stainless steel can be bonded by a duplex casting process. The bonding of steel and aluminium is complicated and not yet in commercial use for chemical apparatus.

Methods have been devised for evaluating the adhesive strength of such coatings. Some of the results obtained with a mild steel base are given below—

Silver	21,000 lb./sq. in.
Copper	28,500 ,, ,,
Nickel	34,000 ,, ,,
18.8 stainless	35,500 ,, ,,

Welds in coated materials completely satisfy the requirements of tightness, mechanical strength and chemical stability. In general the base metal is electric arc-welded, using covered electrodes. The seam is then thoroughly cleaned and the coated side welded, using the coating material.

An interesting recent application of bi-metal plates is in the construction of heavy-duty bearings. The coated plate is bent into the required shape, and a supplementary metallurgical treatment secures the required anti-friction properties. (*Communicated by the Director of Scientific Research, Ministry of Aircraft Production.*)

A Survey of Corrosion Literature in 1939, by S. M. Norwood. (Report of the Corrosion Committee of the Electrochemical Society). (*Trans. Electrochemical Society, 1940, 77, p. 14*).

This follows on reports in earlier years. It is divided into two sections, dealing respectively with corrosion literature in the eastern and western hemispheres. There is a bibliography totalling 258 references. Copies will be made available to members as R. and C. 181. (*Communicated by the B.N.F. Bulletin.*)

WELDING, BRAZING.

Arc Welding Chrome-Vanadium Steel, by I. Z. Kagan. (*The Welding Industry, November, 1940, Vol. VIII, No. 10, p. 276*).

Material used. Coating of electrodes. Welding with electrodes cut from prepared metal. Low carbon electrodes. Corrosion tests. Conclusions. It

has now been found possible to apply the arc-welding process to the fabrication of the internal parts of the ammonia synthesis plant, where it has been found to be much more efficient and economical than gas welding.

Welding Magnesium and its Alloys, by W. Spraragen and G. E. Claussen. (*The Welding Industry, November, 1940, Vol. VIII, No. 10, p. 282, 3 figs.*).

Oxy-acetylene welding methods have been developed rather fully, but the flux, which is required, is troublesome to remove with the thoroughness that is essential. Properties of magnesium and some of its alloys. Solidification temperatures. Conductivity thermal electrical (100° to 300°C.) C.G.S. percentage of copper units (I.A.C.S.). Average coefficient of thermal expansion per °C. (20° to 300°C.). Static tensile properties : (yield strength ; tensile strength ; elongation ; condition). Correct and incorrect types of joint for magnesium and its alloys. Flux is very likely to be overlooked in cleaning the incorrect joints after welding. Flange welds for sheet not over 0.051 in. thick. Fluxes for welding magnesium alloys. Preparation of butt joints for torch welds. Finishing the weld. Structure. Cracks.

Repair by Welding of a Cast-steel Hydraulic Cylinder. (*The Welder, July-August, 1940, Vol. XII, No. 75, p. 98, 10 figs.*).

Welding as a method of repair has become scarcely less important, certainly under present conditions, than as a method of fabrication, a pertinent example being the welding of the cast-steel cylinder of a 2,000-ton cable-sheathing press. The press is part of the cable-sheathing equipment of Aberdare Cables, Ltd., South Wales. It is imperative that the press should not remain idle for a day longer than could possible be avoided. Illustrations : cracked hydraulic cylinder ; seized ram in cylinder ; drilling to release ram ; half cylinder prepared for welding ; cylinder assembled for welding ; welding of fracture ; partially completed weld ; boring cylinder for liner ; assembly of cylinder and new liner. The total delay from the breakdown to restarting was thus under six weeks, against eight months stated to be required to obtain a replace cylinder from the original makers of the press.

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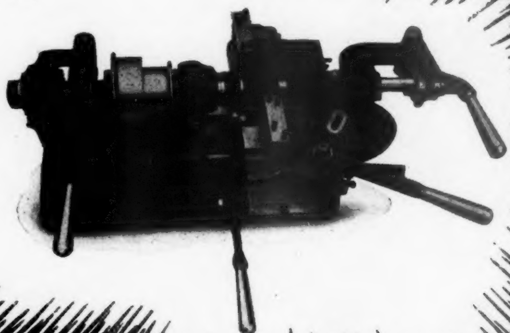

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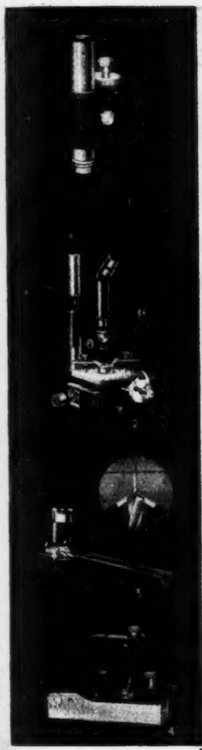

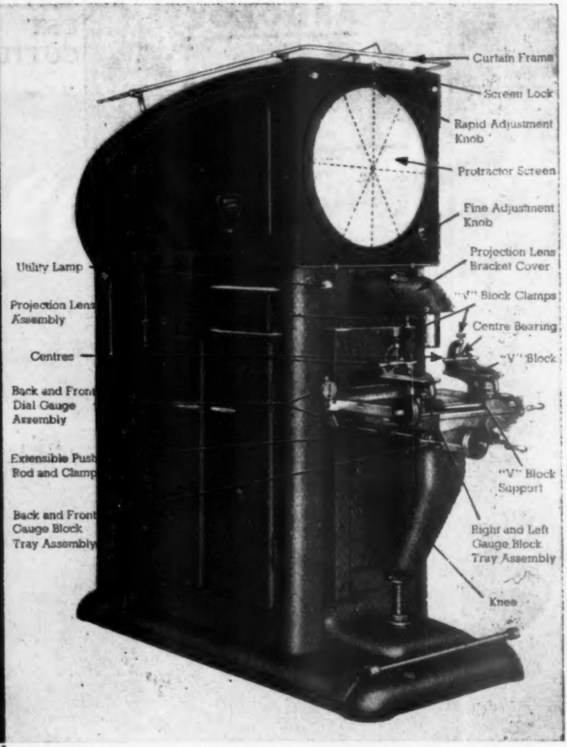

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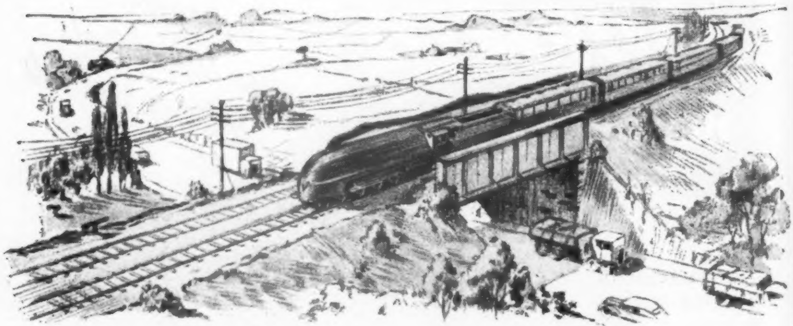

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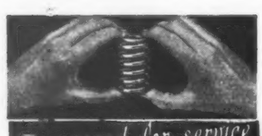

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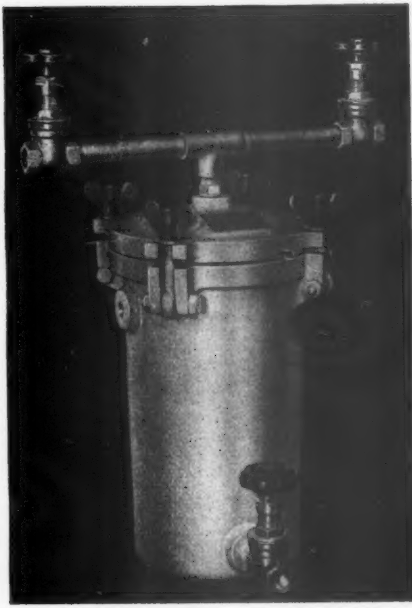

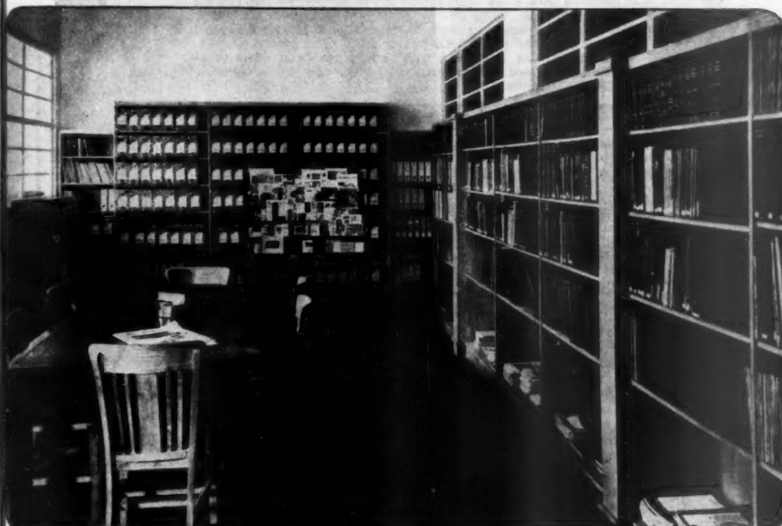

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